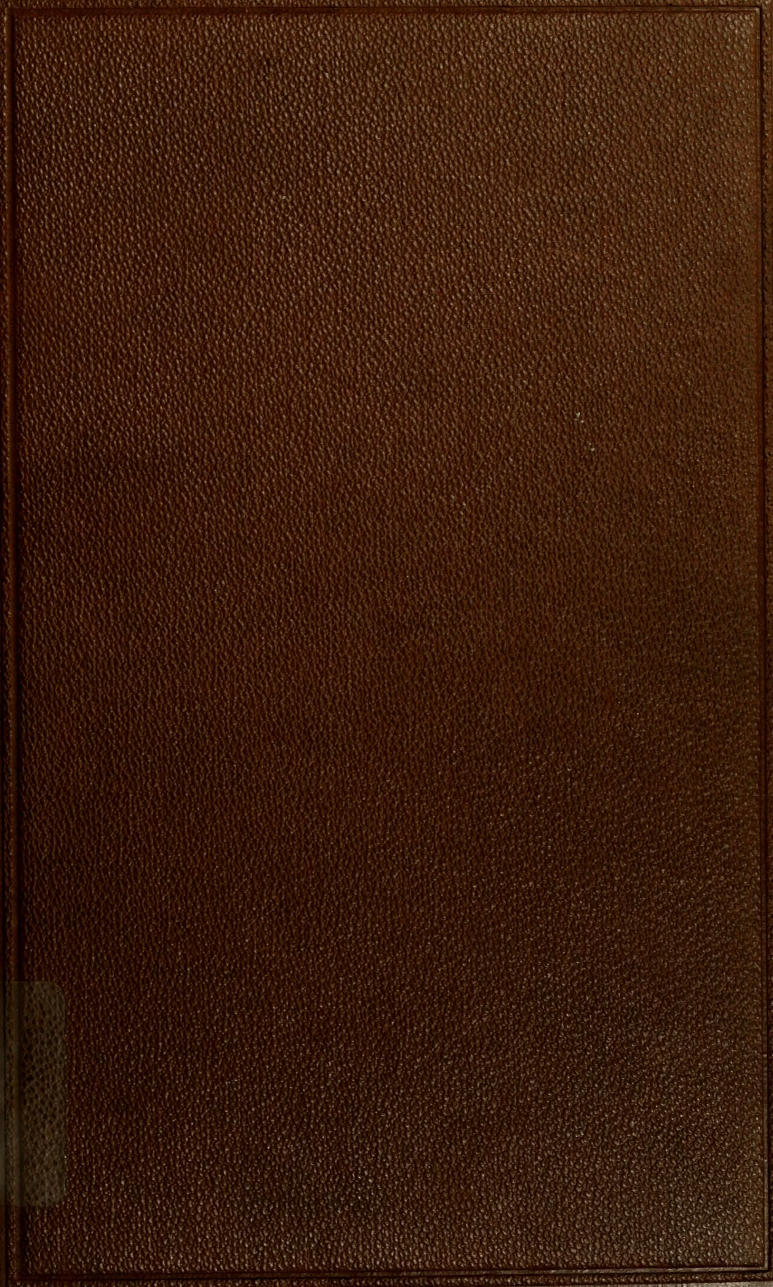




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ERRATA.

- p. 112. *Echinus gilchristi*. For "no spines or buccal plates" read "no spines on buccal plates."
- p. 122, line 40. Delete "above."
- p. 138. *Strongylocentrotus*. For "value" read "valve."
- p. 148. *Clypeaster adouini*. For "petaloid area usually 3—5 as long as test" read "petaloid area usually three-fifths as long as test."
- p. 157, line 27. For "The *Challenger* specimens" read "The *Challenger* specimen."
- p. 161, line 26. Delete "only."
- p. 167. *Echinocyamus scaber*. For "glossy tubercles" read "glassy tubercles."
- p. 178. *Micropetalon purpureum*. For "Test oral" read "Test oval."
- p. 191. *Pourtalesia*. Insert "5" after "interambulacrum."



LIBRARY
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OF THE
RECENT SEA-URCHINS
(ECHINOIDEA)

IN THE
COLLECTION OF THE BRITISH MUSEUM
(NATURAL HISTORY)

BY

59.39.5107(42)

HUBERT LYMAN CLARK

CURATOR OF ECHINODERMA, MUSEUM OF COMPARATIVE ZOOLOGY,
CAMBRIDGE, MASS., U.S.A.



LONDON :

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PREFACE

DR. H. L. CLARK studied the Sea-urchins in the Zoological Department for some months in 1924 ; in this time he examined and redetermined the collection, a task that would have been impossible for any one but an assiduous worker who was thoroughly familiar with the group. The notes and descriptions that he made in London form the basis of this catalogue, the preparation of which has occupied his time since his return to America.

The collection is one of great historical interest ; it contains about 8,000 specimens belonging to nearly 400 species, about two-thirds of the known species of the group.

The principal aim of Dr. Clark's catalogue is to make known to his fellow-workers the contents of the collection ; he has also put forward new views as to the arrangement of certain difficult families and genera that are the result of his work in London. Although the catalogue is not a monograph of the Echinoidea, the species not in the collection being excluded, it has been written in such a way as to serve as a handbook for the identification of most Sea-urchins, except rarities.

Dr. Clark has not seen proofs, and I am indebted to Mr. G. A. Smith for assistance in correcting them, and also for the preparation of the index.

C. TATE REGAN

(Keeper of Zoology).

March, 1925.

INTRODUCTION

A HUNDRED years ago the first important paper on sea-urchins to be published in the English language appeared in the *Annals of Philosophy* (n.s., vol. 10, pp. 423-31); it was entitled 'An Attempt to divide the Echinida, or Sea Eggs, into Natural Families'. The author was John Edward Gray, who subsequently became one of the most eminent systematic zoologists of the nineteenth century. His connexion with the British Museum began in 1824, and the 'Synopsis' of the collections published in that year shows that there was already quite a good series of 'Echinida or sea eggs' in the Museum at that time. Gray's important paper may be regarded as the foundation for a Catalogue of the Echinoidea in the British Museum, although it lists only about fifty species.

For thirty years Gray continued his studies, and, at intervals, his publications on the Echinoids; in 1855 he published his important 'Catalogue of the Recent Echinida or Sea Eggs in the Collection of the British Museum. Part I. Echinida Irregularia'. The half-dozen plates which illustrate this catalogue are admirably done and serve their purpose perfectly even to-day. Gray had an extraordinary systematic sense, and all of his thirty-three genera of Echinida Irregularia are in use to-day, except one or two taken from other writers and not seen by him, and two or three based on immature or abnormal specimens. His definitions were inadequate and caused his fellow-workers much trouble, but he certainly had exceptional ability to recognize species and genera.

After Gray's death and the removal of the collections to South Kensington, Professor F. Jeffrey Bell had charge of the Echinoids (along with other groups), and he published many brief papers on the Class. His only considerable volume is a 'Catalogue of the British Echinoderms in the British Museum (Natural History)', which appeared in 1892. During the forty years of Bell's control the collection received many notable additions, which increased its value even more than

they did its size. The most important of these may be grouped under five heads.

1. The *Challenger* collection.—The Echinoids which were gathered during the voyage of the *Challenger* received more than ordinary attention from her chief naturalist, Sir C. Wyville Thomson, who published the first descriptions and figures of some of the more striking novelties. Ultimately the entire collection was sent to Dr. Alexander Agassiz at the Museum of Comparative Zoölogy, Cambridge, U.S.A., and his report thereon appeared as one of the famous *Challenger* Reports. The collection contained, according to Dr. Agassiz's list, hundreds of specimens of at least 140 species, of which more than 50 were new forms, first collected by the *Challenger*. This was undoubtedly the most considerable addition to the Echinoids of the British Museum ever made at one time, and with the series contributed a few years earlier by the *Lightning*, the *Knight Errant*, and the *Porcupine*, it placed the collection in the very front rank.

2. The *Alert* collections.—The Museum has often been fortunate in the co-operation of naval officers in adding to its collections, but so far as the Echinoids are concerned, two names stand out, Dr. R. W. Coppinger and Dr. P. W. Bassett-Smith. Dr. Coppinger was surgeon and naturalist of the *Alert* during her surveying work in the vicinity of the Straits of Magellan, along the eastern coast of Australia, in Torres Strait, and in the Indian Ocean. His abilities as a collector must have been extraordinary, for though he had no special knowledge of sea-urchins and no facilities for collecting in even moderately deep water, the material which he added to the collection included examples of about forty species. It is to be regretted that the brief reports published on these Echinoids were not at all commensurate with their value.

3. The *Penguin* and *Egeria* collections.—Dr. P. W. Bassett-Smith, the surgeon and naturalist on these vessels while they were surveying off north-western Australia, in the Arafura and Banda Seas, and on Macclesfield Bank in the China Sea, was, like Dr. Coppinger, an exceptionally capable collector, and the material which he added to the series at the British Museum stands out as one of great importance; it was particularly rich in examples of small species and in young

individuals. As nearly as I can estimate, Dr. Bassett-Smith contributed specimens of about thirty species, of which at least five were new to science.

4. The Willey and the Gardiner collections.—Of other collections of Echinoids received at the Museum some have been of such importance that special reports were published about them; two such collections deserve special mention. One was that of Professor Arthur Willey, F.R.S., who brought back from New Britain and the Loyalty Islands examples of a dozen or more species; of these, five were new to science, although only one was so recognized in the published report. An even more valuable contribution was that of Professor J. Stanley Gardiner, F.R.S., who, on his return to England from the Percy Sladen Trust Expedition to the Indian Ocean, presented a superb series representing at least thirty species, beautifully preserved and with accurate locality labels. This fine collection included examples of at least five very distinct new species and other material of great interest.

5. The Antarctic collections.—Since the opening of the twentieth century, the British Antarctic expeditions have been a source of much new material, and the naturalists of the *Discovery*, *Southern Cross*, *Terra Nova*, and *Quest* have all brought back collections of value, including examples of many interesting new species, and series of species described by Koehler and Mortensen from the Scottish, French, German, and Swedish Antarctic expeditions.

The British Museum collection of Echinoidea now ranks as one of the foremost collections of the world in the number of species represented, and includes a large number of types and figured specimens. At the present time it contains about eight thousand specimens, representing 382 valid species and 16 named varieties, grouped in 146 genera. I think that the collection must rank first in the world in regard to the large size of the individuals of many of the species. Many of these large specimens are in the series shown in the Exhibition Gallery, but a still greater number occur in the study collection. For several species I have given the principal dimensions of the largest specimen, believing that these figures are of interest and of scientific value.

Owing to the loss of some of the material which Gray studied, and to the fact that neither Bell, Wyville Thomson, Alexander Agassiz, nor even Mortensen designated type-specimens (except now and then), it has not been possible to find the types of all the species described by these workers, which should be in the Museum. But what is undoubtedly type material of 111 forms, including those described as new in the present report, is at hand, and the following list gives their names and authors and the view here taken as to their validity.

LIST OF TYPE MATERIAL OF ECHINOIDEA IN THE BRITISH MUSEUM.

Name of Form.	Author.	Date.	Nature of Type.	Validity of Form.
<i>Chondrocidaris brevispina</i>	H. L. Clark	1925	Holotype	Valid.
<i>Prionocidaris baculosa</i> var. <i>lineata</i>	H. L. Clark	1925	Holotype	Valid.
<i>Prionocidaris badia</i>	H. L. Clark	1925	Holotype	Valid.
<i>Dorocidaris abyssicola</i>	A. Agassiz	1869	Cotype	Valid= <i>Cidaris abyssicola</i> .
<i>Dorocidaris blakei</i>	A. Agassiz	1878	Cotype	Valid= <i>Cidaris blakei</i> .
<i>Dorocidaris micans</i>	Mortensen.	1903	Holotype	Valid= <i>Cidaris micans</i> .
<i>Tretocidaris spinosa</i>	Mortensen	1903	Holotype	Valid.
<i>Dorocidaris bracteata</i>	A. Agassiz	1879	Cotype	Valid= <i>Stylocidaris bracteata</i> .
<i>Stylocidaris bracteata</i> var. <i>albidens</i>	H. L. Clark	1925	Holotype & paratype	Valid.
<i>Dorocidaris panamensis</i>	A. Agassiz	1892	Cotype	Valid= <i>Stylocidaris panamensis</i> .
<i>Stereocidaris ingolfiana</i>	Mortensen	1903	Cotype	Valid.
<i>Austrocidaris gigantea</i>	H. L. Clark	1925	Holotype & paratype	Valid.
<i>Austrocidaris platycantha</i>	H. L. Clark	1925	Holotype & paratype	Valid.
<i>Goniocidaris florigera</i>	A. Agassiz	1881	Cotype	Valid= <i>Discocidaris florigera</i> .
<i>Schizocidaris assimilis</i>	Mortensen	1903	Holotype	= <i>Discocidaris florigera</i> .
<i>Discocidaris serrata</i>	Mortensen	1903	Cotypes	= <i>Discocidaris florigera</i> .
<i>Cidaris curvatispinis</i>	Bell	1893	Holotype	Valid= <i>Acanthocidaris curvatispinis</i> .
<i>Porocidaris elegans</i>	A. Agassiz	1879	Cotypes	Valid= <i>Histocidaris elegans</i> .

Name of Form.	Author.	Date.	Nature of Type.	Validity of Form.
<i>Porocidaris purpurata</i>	Wyville Thomson	1872	Cotypes	Valid = <i>Histocidaris purpurata</i> .
<i>Aspidodiadema tonsum</i>	A. Agassiz	1879	Cotypes	Valid.
<i>Aspidodiadema microtuberculatum</i>	A. Agassiz	1879	Cotypes	Valid = <i>Plesiodiadema microtuberculatum</i> .
<i>Coenopodina superba</i>	H. L. Clark	1925	Holotype & paratypes	Valid.
<i>Micropyga nigra</i>	H. L. Clark	1925	Holotype & paratype	Valid.
<i>Micropyga tuberculata</i>	A. Agassiz	1879	Cotypes	Valid.
<i>Phormosoma bursarium</i>	A. Agassiz	1881	Cotypes	Valid.
<i>Phormosoma rigidum</i>	A. Agassiz	1881	Cotypes	Valid ?
<i>Phormosoma hoplacantha</i>	Wyville Thomson	1887	Holotype	Valid = <i>Echinostoma hoplacantha</i> .
<i>Phormosoma luculentum</i>	A. Agassiz	1879	Cotypes	Valid = <i>Echinostoma luculentum</i> .
<i>Phormosoma tenue</i>	A. Agassiz	1879	Cotypes	Valid = <i>Echinostoma tenue</i> .
<i>Phormosoma uranus</i>	Wyville Thomson	1877	Cotypes	Valid = <i>Echinostoma uranus</i> .
<i>Phormosoma zealandiac</i>	A. Agassiz	1904	Holotype	Valid ? = <i>Echinostoma zealandiac</i> .
<i>Phormosoma asterias</i>	A. Agassiz	1881	Cotypes	Valid = <i>Kamptosoma asterias</i> .
<i>Asthenosoma heteractis</i>	Bedford	1900	Holotype	Valid ?
<i>Araeosoma belli</i>	Mortensen	1903	Holotype	Valid.
<i>Asthenosoma coriaceum</i>	A. Agassiz	1879	Cotypes	Valid = <i>Araeosoma coriaceum</i> .
<i>Asthenosoma gracile</i>	A. Agassiz	1881	Cotypes	Valid = <i>Araeosoma gracile</i> .
<i>Asthenosoma pellucidum</i>	A. Agassiz	1879	Cotypes	Valid = <i>Araeosoma pellucidum</i> .
<i>Asthenosoma tessellatum</i>	A. Agassiz	1879	Holotype	Valid = <i>Araeosoma tessellatum</i> .
<i>Araeosoma violaceum</i>	Mortensen	1903	Cotypes	Valid.
<i>Salenia pattersoni</i>	A. Agassiz	1878	Cotypes	Valid.
<i>Salenia miliaris</i>	A. Agassiz	1898	Cotypes	Valid = <i>Salenocidaris miliaris</i> .
<i>Salenia profund</i>	Duncan	1877	Holotype	Valid = <i>Salenocidaris profund</i> .
<i>Podocidaris prionigera</i>	A. Agassiz	1879	Cotypes	Valid = <i>Pygmaecidaris prionigera</i> .

Name of Form.	Author.	Date.	Nature of Type.	Validity of Form.
<i>Hyposiechinus coronatus</i>	Mortensen	1903	Cotype	Valid.
<i>Trigonocidaris monolini</i>	A. Agassiz	1879	Holotype	Valid = <i>Orechinus monolini</i> .
<i>Cottaldia forbesiana</i>	A. Agassiz	1879	Holotype	Valid = <i>Prionechinus forbesianus</i> .
<i>Prionechinus sagittiger</i>	A. Agassiz	1879	Cotypes	Valid ?
<i>Opechinus spectabilis</i>	Mortensen	1904	Holotype	Valid.
<i>Salmacis rubricincta</i>	H. L. Clark	1925	Holotype & paratypes	Valid.
<i>Salmacis alexandri</i>	Bell	1884	Cotypes	A dubious variety of <i>S. virgulata</i> .
<i>Temnotrema pallescens</i>	H. L. Clark	1925	Holotype	Valid.
<i>Mespilia globulus</i> var. <i>albida</i>	H. L. Clark	1925	Holotype	Valid ?
<i>Mespilia whitmachi</i>	Bell	1881	Holotype	A dubious variety of <i>M. globulus</i> .
<i>Microcyphus elegans</i>	Mortensen	1904	Cotype	Valid = <i>Microcyphus compsus</i> (<i>elegans</i> was preoccupied).
<i>Echinus atlanticus</i>	Mortensen	1903	Cotypes	Valid.
<i>Echinus gilchristi</i>	Bell	1904	Cotypes	Valid.
<i>Echinus gracilis</i>	A. Agassiz	1869	Cotype	Valid.
<i>Echinus horridus</i>	A. Agassiz	1879	Cotypes	Valid.
<i>Echinus multidentatus</i>	H. L. Clark	1925	Holotype	Valid.
<i>Salmacis rufa</i>	Bell	1894	Cotypes	Valid = <i>Lytechinus rufus</i> .
<i>Lytechinus variegatus</i> var. <i>pallida</i>	H. L. Clark	1925	Holotype & paratypes	Valid.
<i>Nudechinus rubripunctatus</i>	H. L. Clark	1925	Holotype & paratype	Valid.
<i>Gymnechinus abnormalis</i>	H. L. Clark	1925	Holotype & paratype	Valid.
<i>Gymnechinus versicolor</i>	Mortensen	1904	Cotypes	Valid.
<i>Clypeaster miniacens</i>	H. L. Clark	1925	Holotype	Valid.
<i>Clypeaster speciosus</i>	Verrill	1870	Cotype	Valid.
<i>Laganum centrale</i>	H. L. Clark	1925	Holotype & paratype	Valid.
<i>Laganum mirabile</i>	H. L. Clark	1925	Holotype	Valid.
<i>Echinocyamus emarginatus</i>	H. L. Clark	1925	Holotype	Valid ?
<i>Echinocyamus grandis</i>	H. L. Clark	1925	Holotype	Valid.
<i>Echinoneus abruptus</i>	H. L. Clark	1925	Holotype	Valid ?
<i>Nucleolites occidentalis</i>	Bell	1887	Holotype	= <i>Rhyncholampas cariboeorum</i> .
<i>Catopygus recens</i>	A. Agassiz	1879	Cotypes	Valid = <i>Hypscholampus recens</i> .

Name of Form.	Author.	Date.	Nature of Type.	Validity of Form.
<i>Palaeolampas crassa</i>	Bell	1880	Holotype	Valid = <i>Echinolampas crassa</i> .
<i>Echinolampas koreana</i>	H. L. Clark	1925	Holotype	Valid.
<i>Cystechinus clypeatus</i>	A. Agassiz	1879	Holotype	Valid = <i>Urechinus clypeatus</i> .
<i>Urechinus naresianus</i>	A. Agassiz	1879	Cotypes	Valid.
<i>Cystechinus wyvillei</i>	A. Agassiz	1879	Cotypes	Valid = <i>Urechinus wyvillei</i> .
<i>Cystechinus rescica</i> .	A. Agassiz	1879	Cotypes	Valid = <i>Pilematechinus rescica</i> .
<i>Calymne relicta</i>	Wyville Thomson	1877	Holotype	Valid.
<i>Echinocrepis cuneata</i>	A. Agassiz	1879	Cotype	Valid.
<i>Spatagocystis challengerii</i>	A. Agassiz	1879	Cotypes	Valid.
<i>Pourtalesia ceratopyga</i>	A. Agassiz	1879	Cotypes	Valid = <i>Ceratophysa ceratopyga</i> .
<i>Pourtalesia rosea</i>	A. Agassiz	1879	Holotype	Valid = <i>Ceratophysa rosea</i> .
<i>Pourtalesia carinata</i>	A. Agassiz	1879	Cotypes	Valid = <i>Helgocystis carinata</i> .
<i>Pourtalesia hispida</i>	A. Agassiz	1879	Cotypes	Valid.
<i>Pourtalesia laguncula</i>	A. Agassiz	1879	Cotypes	Valid.
<i>Pourtalesia phiale</i>	A. Agassiz	1881	Holotype	Valid = <i>Echinosigra phiale</i> .
<i>Aerope rostrata</i>	Norman	1876	Holotype	Valid = <i>Aeropsis rostrata</i> .
<i>Aceste bellidifera</i>	Wyville Thomson	1877	Cotype	Valid.
<i>Genicopatagus affinis</i>	A. Agassiz	1879	Cotypes	Valid.
<i>Palaeopneustes hystrix</i>	A. Agassiz	1880	Cotype	Valid = <i>Archaeopneustes hystrix</i> .
<i>Argopatagus vitreus</i>	A. Agassiz	1879	Cotypes	Valid.
<i>Palacotropus loveni</i>	A. Agassiz	1879	Cotypes	Valid.
<i>Homolampas fulva</i>	A. Agassiz	1879	Cotypes	Valid.
<i>Pericostmus abatoides</i>	H. L. Clark	1925	Holotype & paratype	Valid.
<i>Linthia rostrata</i>	E. A. Smith	1878	Holotype	Valid = <i>Protenaster rostrata</i> .
<i>Faorina chinensis</i>	Gray	1851	Cotypes	Valid.
<i>Hemiaster elongatus</i>	Koehler	1908	Cotypes	Valid = <i>Abatus koehleri</i> (<i>elongatus</i> was pre-occupied).
<i>Schizaster moseleyi</i>	A. Agassiz	1881	Cotypes	Valid = <i>Bristaster moseleyi</i> .

Name of Form.	Author.	Date.	Nature of Type.	Validity of Form.
<i>Schizaster claudicans</i>	A. Agassiz	1879	Holotype	Valid = <i>Moiropsis claudicans</i> .
<i>Brissopsis alta</i>	Mortensen	1907	Cotypes	Valid.
<i>Metalia latissima</i>	H. L. Clark	1925	Holotype	Valid.
<i>Eobriuss townsendi</i>	Bell	1904	Cotypes	Valid = <i>Metalia townsendi</i> .
<i>Rhynobriuss hemias- troides</i>	A. Agassiz	1879	Holotype	Valid.
<i>Brissus damesi</i>	A. Agassiz	1881	Cotypes	Valid.
<i>Cionobriuss regularis</i>	H. L. Clark	1925	Holotype	Valid.
<i>Cionobriuss revinctus</i>	A. Agassiz	1879	Cotypes	Valid.
<i>Palaeopneustes murrayi</i>	A. Agassiz	1879	Cotypes	Valid = <i>Linopneustes murrayi</i> .
<i>Spatangus subcarinatus</i>	Gray	1845	Cotypes	Valid = <i>Lovenia subcarinata</i> .
<i>Echinocardium capense</i>	Mortensen	1907	Cotypes	Valid.

The above list shows that 49 forms are represented by the holotype (often with paratypes). Of the 111 forms, Agassiz described 51, Mortensen 14, Bell 8, and Wyville Thomson 5; 25 are described in the present volume for the first time. There is no doubt that other type material exists in the collection, but it is undesigned and I did not find the specimens to fit the descriptions. The types of Wyville Thomson's species *Cidaris nutrix*, *Phormosoma placenta*, *Calcearia fenestrata*, and *Pourtalesia jeffreysi*, if in existence, ought to be in the collection, but I did not discover them.

The types of Gray's *Echinarachnius zelandiae* and *Kleinia luzonica*, which I particularly hoped to see, were not found and probably are no longer in existence. The same is perhaps true of most of Gray's species, but it is quite possible that some may yet be discovered among specimens without labels.

The present catalogue is arranged in the sequence of orders and families that seems to me most natural, from our present knowledge of the class. It is not essentially different from that generally adopted by Mortensen, Kochler, Döderlein, and myself during the past twenty years. The only innovations of importance are in connexion with some of the more primitive forms that have hitherto been placed in the Spatan-

gina. The genera are arranged also in what seems to me their natural sequence, so far as a linear arrangement can express it, but for convenience the species are arranged alphabetically.

In conclusion, I have to express my thanks to the authorities of the Museum of Comparative Zoölogy for the leave of absence which made my visit to London possible, and particularly to Mr. Samuel Henshaw, Director of the Museum, for his sympathy and interest in my plans. Also I have to thank the authorities of the British Museum (Natural History) for their cordial welcome and for the facilities they gave me for my work ; I am particularly indebted to Mr. C. C. A. Monro, B.A., in charge of the Collection of Echinoderms, for his kindness and help, and to Mr. G. A. Smith, whose knowledge of the collection was invaluable. Finally, I have to acknowledge the help and advice given to me by Dr. Mortensen, of Copenhagen, and by Professor H. L. Hawkins, of Reading.

HUBERT LYMAN CLARK.

CAMBRIDGE, MASS., U.S.A.

December 24, 1924.

LIST OF IMPORTANT PUBLICATIONS DEALING WITH THE TAXONOMY OF THE RECENT ECHINOIDEA

- A. Agassiz, 1872-4. Revision of the Echini. Mem. M. C. Z., vol. 3, 4to, 762 pp., 94 pls. (The foundation of our modern knowledge of sea-urchins.)
- , 1881. Report on the Scientific Results of the Voyage of H.M.S. *Challenger*. Zoölogy, vol. 3, pt. 9. Report on the Echinoidea, 4to, 321 pp., 65 pls.
- and H. L. Clark, 1907-9. Hawaiian and other Pacific Echini. Mem. M. C. Z., vol. 34, nos. 1-3, 4to, 203 pp., 89 pls. (Contains a revision of the families Saleniidae, Arbaciidae, Aspidodiadematidae, and Diadematidae.)
- L. Agassiz and E. Desor, 1846-8. Catalogue des espèces, des genres et des familles d'Echinides. In Ann. Sci. Nat. (3), Zoologie, vols. 6, 7, and 8, 8vo, 167 pp., 2 pls. (Of great historical importance, but the diagnoses are too brief.)
- H. L. Clark, 1907. The Cidaridae. Bull. M. C. Z., vol. 51, no. 7, 8vo, 66 pp., 11 pls. (A complete but now somewhat antiquated revision of the family.)
- , 1912-17. Hawaiian and other Pacific Echini. Mem. M. C. Z., vol. 34, no. 4, 4to, 174 pp., 32 pls.; and vol. 46, nos. 1 and 2, 4to, 283 pp., 40 pls. (Contains revisions of the families not included in Agassiz and Clark, 1907-9.)
- L. Döderlein, 1887. Die japanischen Seeigel, Pt. 1, 4to, 59 pp., 11 pls. (An important contribution to our knowledge of the Cidaridae.)
- , 1906. Die Echinoiden der deutschen Tiefsee-Expedition (*Valdivia* Report), 4to, 227 pp., 42 pls.
- J. E. Gray, 1855. Catalogue of the Recent Echinida or Sea Eggs in the collection of the British Museum, Pt. I, Echinida Irregularia, 12mo, 69 pp., 6 pls. (Historically valuable; figures very good, but diagnoses inadequate.)
- R. Koehler, 1914. Echinoderma of the Indian Museum. Part VIII. Echinoidea (I). Spatangidés, 258 pp., 20 pls.
- , 1922. Same series, Part IX, Echinoidea (II). Clypeastridés et Cassidulés, 161 pp., 15 pls.
- J. C. H. de Meijere, 1904. Die Echinoidea der *Siboga*-Expedition. 4to, 252 pp., 23 pls.
- H. Mortensen, 1903. The Danish *Ingolf* Expedition, vol. 4. Echinoidea (Part I), 4to, 193 pp., 21 pls., map. (Includes a critical discussion of the classification of the Echinoidea.)
- , 1904. The Danish Expedition to Siam, 1899-1900. Echinoidea (I). Dansk. Selsk. Skr. (7) 1, No. 1, small 4to, 124 pp., 7 pls., map. (Valuable discussion of several families, particularly the Temnopleuridae.)
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CATALOGUE OF SEA-URCHINS.

Class ECHINOIDEA, Bronn.

Echinoderms with alimentary, reproductive, nervous and water-vascular systems enclosed within a 'test' or shell, usually rigid (rarely flexible), made up of plates which bear movable spines.

Order CIDAROIDA, Duncan.

Test regular, with periproct at centre of upper side, and peristome, provided with jaws, at centre of lower side. Ambulacral plates simple. Peristome plated, the ambulacral plates continuing to mouth. No sphaeridia and no peristomal gills.

Family CIDARIDAE, J. Müller.

Test stout, with relatively few plates in each interambulacral column; each plate with one primary spine or none. Primary spines very large. Primary tubercles perforate.

The collection of Cidaridae includes more than 700 specimens of 45 species and 4 named varieties. In my revision of the family (Bull. M.C.Z., **51**, 1907, No. 7) 15 genera of recent Cidaridae were recognized. In 1909 Mortensen (Deutsch. Südpolar-Exp. Ech., p. 53) gave an important review and criticism of my work, and listed 21 genera, which he thought should be recognized. Since then he has abandoned one of these (*Plococidaris*) and has instituted 2 more (*Ctenocidaris*, *Ogmocidaris*), making 22 genera which he recognizes at the present time.

The care and thoroughness with which Dr. Mortensen does his work, his sound judgement and his very extensive knowledge of Echinoidea compel one to hesitate seriously before disagreeing with so worthy an authority, but I believe we are in danger of magnifying trivial differences and overlooking real relationships if we recognize too large a number of genera. For this reason I have scrutinized anew, with care, all of the genera which either Mortensen or I have recognized, and I think that the grouping of the family which I now propose is a step towards the natural classification which we seek. I first list the 18 genera here recognized, with such comments on each as are essential, and I then give an artificial key to

show how they may be distinguished from each other. This key is as brief and as definite as is possible; it would need considerable elaboration to guard against all the perplexing species and individuals which occur so frequently. That some of these are due to hybridization as Mortensen has suggested is not impossible, but I am loath to accept that as an explanation without further and more direct evidence.

I am now inclined to lay more stress on the characters afforded by the pedicellariae than I did 17 years ago. I have become convinced that *essentially* different large globiferous pedicellariae do not occur in species of Cidaridae of the same natural genus, although there are some perplexing examples of two kinds having been found on the same individual! The explanation of these is not yet clear, but they prevent our regarding the form of the pedicellariae as the prime character of any genus. It is, however, very useful in preparing an artificial key.

The following 18 genera are not of uniform validity. Some are undoubtedly more natural than others, but I hope that nearly all will stand the test of more material and further intensive study.

PHYLLACANTHUS Brandt, 1835. Prodrôme, p. 267.

The elimination of *P. baculosa* and its allies leaves this a natural group of very large Indo-Pacific Cidarids.

CHONDROCIDARIS A. Agassiz, 1863. Bull. M.C.Z., 1, p. 18.

This genus, although evidently allied to *Phyllacanthus*, has such remarkable primary spines and such characteristic features of both test and pedicellariae that there can be little question as to its validity. It occurs from Mauritius to Hawaii.

PRIONOCIDARIS A. Agassiz, 1863. Bull. M.C.Z., 1, p. 18.

Including *Plococidaris* Mortensen, this is a fairly homogeneous group, except possibly for *P. verticillata*, which shows a certain resemblance to *Eucidaris*. The much discussed genus *Stephanocidaris* A. Agassiz, as used by Agassiz and by myself, is undoubtedly the same as *Prionocidaris*, but the name itself is a synonym of *Goniocidaris*. This is an Indo-Pacific genus ranging from Mauritius to Hawaii.

CIDARIS Leske, 1778. Add. ad Klein, pp. xvii and 61.

In my revision of the Cidaridae (1907, Bull. M.C.Z., 51, p. 177) I regarded *C. tribuloides* as the type of this genus. Subsequent correspondence with Dr. F. A. Bather and Dr. Mortensen, most of which was indirect and was published in the *Annals and Magazine of Natural History* during 1908, convinced me that *Echinus cidaris* L. is the type of *Cidaris*,

Hence *Dorocidaris* A. Agassiz, to which *Echinus cidaris* certainly belongs, is a synonym of *Cidaris*.

Examination of further material, including the holotype in the British Museum, and study of Mortensen's elaborate description and figures published in 1910 (Bull. U.S. Nat. Mus., 74), have convinced me that *Calocidaris micans* is merely a *Cidaris* with highly polished spines. The characters of the test supposed to distinguish *Calocidaris* do not hold, and we are thus able to dispense with a monotypic genus, the recognition of which serves no useful purpose.

The genus *Cidaris* is a North Atlantic, Mediterranean and West Indian group, occurring at moderate depths. The European *C. cidaris* has been found at St. Paul's Rocks.

TRETOCIDARIS Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 16.

The opportunity to examine the type of *T. spinosa* in the British Museum, taking into account also the fairly numerous specimens of *T. bartletti* which I have seen since 1907, and Mortensen's (1910, Bull. U.S. Nat. Mus., 74, pp. 5-10) very important discussion of *T. bartletti*, has led me to Mortensen's conclusion that these two species must be placed in a genus by themselves. The globiferous pedicellariae are too characteristic to be ignored. The occurrence of large globiferous pedicellariae of the type characteristic of *Stylocidaris* in certain smooth-spined individuals of *T. bartletti* led Mortensen to suggest that such specimens may be hybrids between *S. affinis* and *T. bartletti*. This is certainly plausible, as the two species have a common habitat in the West Indies, but I am not yet convinced that such hybridization occurs. I have however no more satisfactory explanation to offer.

Tretocidaris is confined to the West Indies and South Atlantic.

EUCIDARIS Pomel, 1883. *Class. Meth. Ech.*, p. 109.

This is perhaps the best known and most universally accepted genus of Cidaridae, but it is exceedingly difficult to define satisfactorily. Specimens of *E. tribuloides* from moderately deep water have long spines, and resemble *Stylocidaris* so closely that it is hard to give any reason why they should not be placed in that genus. On the other hand, all three of the living species of *Eucidaris* have a strong tendency to develop short and very stout spines, so that extreme specimens are quite unlike the ordinary stock. The genus is tropicopolitan.

STYLOCIDARIS Mortensen, 1909. *Deutsch. Südpolar-Exp. Ech.*, p. 52.

This genus is not in my opinion a satisfactory one, as it is very near *Eucidaris* at one point, so near *Cidaris* at another

as to be distinguishable only by the large globiferous pedicellariae, and so close to *Tretocidaris* that I have long hesitated to separate it. The contained species form a somewhat heterogeneous group, found in all the warmer seas, from Florida and the Mediterranean to Sagami Bay, the Gulf of Panama and Bass Strait.

STEREOCIDARIS Pomel, 1883. Class. Meth. Ech., p. 110.

This is a poorly defined and perplexing group, usually recognizable by the absence of primaries on the uppermost coronal plates; but this is not marked in small specimens. The resemblance to *Cidaris* on the one hand and to *Austrocidaris* on the other is very great. Often the primary spines carry ridges or 'rings' on the basal part, and usually they are flaring at the tip, but they may be cylindrical or terete; they are commonly $1\frac{1}{2}$ to 3 times as long as the test diameter. The pedicellariae generally lack any end-tooth on the valves and this serves to separate the genus from *Cidaris* without much trouble. The abactinal system is large, often convex, and noticeably thick and stout. This and the primary spines are the best characters for separating the genus from *Austrocidaris*. *Anomocidaris* A. Agassiz and Clark (1907, Haw. Pac. Ech., Cid., p. 30) includes but a single species; this may well be considered as a *Stereocidaris* in which the generic characters reach their extreme.

Stereocidaris is essentially an Indo-Pacific genus ranging from South Africa to Japan and Hawaii, but one isolated species occurs in the North Atlantic from Iceland to Nevis in 165-665 fms. It is not known from the Panamic or Australian regions.

AUSTROCIDARIS H. L. Clark, 1907. Bull. M.C.Z., 51, p. 176.

Since this genus was proposed, a considerable number of Cidaridae from Antarctic and subantarctic seas have been described, most of which are placed in the new genera *Notoxidaris*, *Rhynchocidaris* and *Ctenocidaris*. In connexion with the study of this material Mortensen (1909, Deutsch. Südpolar-Exp. Ech., p. 30) has proposed to separate *A. nutrix* from *A. canaliculata* because of the difference in the abactinal system, and he has suggested a genus *Eurocidaris* for it. I see nothing to be gained by such a separation, and the character on which it is based is not perfectly constant, as there is some diversity with sex, age and condition. Another genus which Mortensen has proposed is *Ogmocidaris* (1921, Vid. Medd., 73, p. 148) for a New Zealand species which seems to me to be an *Austrocidaris*.

Including both *Eurocidaris* and *Ogmocidaris*, *Austrocidaris* is a reasonably homogeneous group of Antarctic and subant-

arctic Cidarids, closely related to *Stereocidaris* (especially by the pedicellariae) but distinguished by the presence of a primary spine on every coronal plate, and the smaller, more compact abactinal system. Moreover, the indications are that the species of *Austrocidaris* all lay large eggs and care for the young during their early development, but that those of *Stereocidaris* do not. The secondary spines of *Austrocidaris*, especially those of the ambulacra, tend to be thick and club-shaped, which is not the case in *Stereocidaris*. From the Antarctic genera to which it is allied *Austrocidaris* is readily distinguished by its unmodified or little modified actinal (oral) spines, but especially by its well-separated ambulacral pores.

CENTROCIDARIS A. Agassiz, 1904. Mem. M.C.Z., **31**, p. 32.

A careful re-examination of the material in the Museum of Comparative Zoölogy forces me to conclude that this genus is valid. I do not see how the species for which it was established can rightly be placed in any other genus. *Centrocidaris* seems to be confined to moderate depths in the eastern tropical Pacific.

GONIOCIDARIS Agassiz and Desor, 1846. Ann. Sci. Nat. (3), **6**, p. 337.

I adopt Mortensen's suggestion (1909, Deutsch. Südpolar-Exp. Ech., p. 52) that the three Australasian species, of coarse habit and stout spines, should compose this genus, and that the East Indian and Japanese species of much more delicate appearance be kept separate from them. The conspicuous bare areas of ambulacra and interambulacra suffice well for a distinguishing character.

DISCOCIDARIS Döderlein, 1885. Arch. f. Naturg., **51** (1), p. 80.

D. mikado is the genotype of *Discocidaris*, and I can see no good reason why *Goniocidaris clypeata* and *G. florigera*, which are doubtfully distinct from each other, or *G. biserialis*, which is a well-marked species, should be generically separated from it. *Discocidaris* is an East Indian genus with 3 or 4 species, extending north to Sagami Bay and south to Tasmania.

CTENOCIDARIS Mortensen, 1910. Swedish S. Polar Exp. Ech., p. 3.

This genus of Antarctic Cidarids seems to be distinguished chiefly by its coarsely serrate actinal (oral) spines. Whether more abundant material will justify its maintenance remains to be seen.

NOTOCIDARIS Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., p. 17.

This is another Antarctic genus, closely related to *Austrocidaris* and *Otenocidaris*. As I have never examined any specimens critically, I am not prepared to discuss its standing.

RHYNCHOCIDARIS Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., p. 5.

The very small and remarkable ambulacral pores seem to be sufficient justification for this genus.

APOROCIDARIS A. Agassiz & Clark, 1907. Mem. M.C.Z., 34, No. 1, p. 36.

This is a puzzling little genus of Cidarids from very deep water in the northern and eastern Pacific and in the Antarctic Ocean south-east of Kerguelen. They are probably most nearly related to *Otenocidaris* and *Austrocidaris*.

ACANTHOCIDARIS Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 21.

This is a very well-marked genus of beautiful Cidarids ranging from Mauritius to Hawaii. Its relation to other members of the family is very obscure.

HISTOCIDARIS Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 22.

When Mortensen established this genus with *Porocidaris elegans* A. Agassiz as the type, he made the statement, 'It is obvious that this species has no relation with *P. purpurata*.' That he subsequently modified this extreme view is indicated by the fact that in 1909 (Deutsch. Südpolar-Exp. Ech., p. 55) he placed *P. purpurata* and the genus *Histocidaris* together in a group distinct from all the other Cidaridae. For my part I can see no generic difference between *P. purpurata* and the species of *Histocidaris*, and as I fully concur with Mortensen's view that none of these recent species should be referred to *Porocidaris*, I refer them all to *Histocidaris*. The genus is widely distributed in the North Atlantic, and throughout the tropical Pacific and Indian Oceans, excepting the south-eastern quarter of the Pacific.

Having thus indicated the 18 genera which I think may wisely be recognized in the family, I give below an artificial key which sets forth their chief distinguishing characters as briefly as possible.

Key to the Genera of Cidaridae.

- A. Pores horizontal or nearly so, distant; surface of interval flat or with a groove connecting the pores, never elevated.
 - B. Primary spines cylindrical or terete, sometimes with longitudinal series of small serrations but never with thorns or projecting ridges or spotted collar; large globiferous pedicellariae very rare or wanting 1. *Phyllacanthus*, p. 9
 - BB. Primary spines with more or less numerous projecting thorns or ridges, at least near base, or collar spotted.
 - C. Interambulacral areas very wide, densely covered with minute tubercles bearing miliary spines and small globiferous pedicellariae; primary spines very stout, with very large thorns or ridges 2. *Chondrocidaris*, p. 10
 - CC. Interambulacral areas not conspicuously widened and not densely clothed with miliaries and small globiferous pedicellariae; primary spines very diverse, but not like those of *Chondrocidaris* 3. *Prionocidaris*, p. 12
- AA. Pores near together, more or less oblique, often separated by an elevation, never connected with each other by a long shallow groove.
 - B'. Globiferous pedicellariae present.
 - C'. Primaries very diverse, but never curved; collar not nearly one-fifth of total length.
 - D'. Abactinal system less than 60 per cent. of horizontal diameter; ambulacral plates (except in young individuals) more than 40 in each column.
 - E'. Ambulacral pores moderate or large, not yoked together by a notch or pit; oral spines usually not much modified.
 - F'. Ambulacra not very wide, about one-third of interambulacra or less; median ambulacral and interambulacral areas without bare, depressed pits, lines or areas (except in *Austrocidaris*).
 - G'. Large globiferous pedicellariae with conspicuous end tooth.
 - H'. Abactinal system not sharply defined, rather irregular in outline, with re-entering angles between genital and ocular plates; primary spines cylindrical or terete, not thorny, often very smooth; large globiferous pedicellariae with a large opening below the end-tooth 4. *Cidaris*, p. 17
 - H'H'. Abactinal system sharply defined, distinctly circular or pentagonal, without re-entering angles between genital and ocular plates; primary spines thorny, or else conspicuously flaring at tip; large globiferous pedicellariae with a mere pore below the end tooth 5. *Tretocidaris*, p. 19
 - G'G'. Large globiferous pedicellariae without a conspicuous single end-tooth.

- h. Large globiferous pedicellariae with the valves 'snout-shaped', i. e. curved, with a large terminal opening and no end tooth; abactinal system sharply defined, circular or pentagonal.
- i. Primaries short, usually about equal to test diameter and rather stout, often very stout and even swollen, rarely slender and elongate, blunt; araeolae little or not sunken; actinostome generally larger than abactinal system. 6. *Eucidaris*, p. 20
- ii. Primaries 1-3 times test diameter, more or less slender and pointed, sometimes prickly, or even thorny or ridged; araeolae more or less deeply sunken; actinostome generally smaller than abactinal system. 7. *Stylocidaris*, p. 22
- hh. Large globiferous pedicellariae with straight valves which are not at all 'snout-shaped'; abactinal system less evidently circular or pentagonal, with re-entering angles between genital and ocular plates.
- i'. Uppermost coronal plates (1, 2, or even 3 in each column) without primary spines, although a tubercle may be present; genital pores in female, and eggs, small; young probably not 'brooded' or protected by mother. 8. *Stereocidaris*, p. 25
- i'i'. All fully developed coronal plates carry primary spines; female genital pores and eggs large; young brooded or protected by mother. 9. *Austrocidaris*, p. 27
- F'F'. Ambulacra very wide, 35-55 per cent. of interambulacra; in both ambulacra and interambulacra there is a tendency to develop bare pits or spaces or a vertical line in the median area.
- g. Ambulacra half as wide as interambulacra or more. 10. *Centrocidaris*, p. 30
- gg. Ambulacra 35-45 per cent. of interambulacra in width.
- h. Size often large (up to 55 mm. in diameter); test and spines coarse and stout; median interambulacral area more or less conspicuously bare and sunken, especially at angles of coronal plates. 11. *Goniocidaris*, p. 30
- hh. Size small (usually under 25 mm. in diameter); test and spines rather more delicate; some primaries at least more or less elongated and pointed; median interambulacral area much less (or usually not all) bare and sunken. 12. *Discocidaris*, p. 32
- E'E'. Ambulacral pores small, close together and often more or less yoked by a notch or pit; oral spines more or less conspicuously modified: Antarctic.

- f. Inner pore of pair not divided into two.
 g. Oral spines very coarsely and conspicuously serrate . . . 13. *Ctenocidaris*, p. 35
 gg. Oral spines flattened, spear-shaped, with entire or irregularly notched margins . . . 14. *Notocidaris*.
 ff. Inner pore of pair divided into two; oral spines more or less flat, irregularly dentate . . . 15. *Rhynchocidaris*.

D'D'. Abactinal system 60-70 per cent. of diameter of test; ambulacral plates few, seldom more than 30 in a column.

16. *Aporocidaris*, p. 36

C'C'. Primary spines long, tapering, often distinctly curved; collar about one-fifth of length of spine . . . 17. *Acanthocidaris*, p. 37

B'B'. No globiferous pedicellariae of any kind; primary spines long, straight, usually cylindrical, white and often shining (unless stained) . . . 18. *Histocidaris*, p. 37

A large proportion of the specimens of Cidaridae in the collection, particularly in the genera *Prionocidaris* and *Stylocidaris*, are young, often very young. Where these occur in series with the adults they can usually be identified without much difficulty, but where there are no adults from the same station, the identification cannot always be made with certainty. I have however assigned all these young individuals to what I believe to be their proper genus and usually to the probable species, but one young specimen has proved so peculiar that I am not even assigning it to a genus. This specimen was taken in Ceylon by Professor Herdman, but bears no more definite locality label. It is possibly the specimen referred to by Herdman and Bell (1904, Ceylon Pearl Oyster Rep., pt. 2, p. 138) under *Stephanocidaris bispinosa* as—'Also another "very young *Cidaris*"'. The test is 8 mm. in diameter and the spines are 15-17 mm. long, with collars 5-5½ mm. Beyond the collar each primary has about 10 longitudinal white ridges of very delicate appearance; between the ridges the colour is olive-grey or yellowish-green, becoming somewhat violet at the tip of the spine. Collar greyish-green with longitudinal rows of white spots on the upper side, but lower surface unspotted. Secondaries light with a longitudinal stripe of dull green. It seems to me that this specimen may be a young *Acanthocidaris*, but as that genus is not yet known from Ceylon, I think it best not to assign it to any genus.

1. PHYLLACANTHUS.

Brandt, 1835. Prodr. Descr. Anim., p. 267.

Type, *Cidarites imperialis* Lamarck, 1816. Anim. s. Vert., 3, p. 54.

Pores horizontal or nearly so, distant, the surface between flat or with a groove; primary spines cylindrical or terete.

1. *Phyllacanthus imperialis*.

Cidarites imperialis Lamarek, 1816. *Anim. s. Vert.*, 3, p. 54.

Phyllacanthus imperialis Brandt, 1835. *Prodrome*, p. 268. A.

Agassiz, 1873. *Rev. Ech.*, pt. 3, pl. 1 f, figs. 2, 6 and 7.

Collar of primary spines without spots or lines; coronal plates few, 5-7; spines stout.

23 specimens, of which 8 are bare tests and 10 are without locality labels. Localities represented are: Red Sea; Mauritius; Rodriguez; Ceylon; Torres Strait; Loyalty Islands (*Willey*); Lifu. A young specimen is labelled 'Indian Ocean', a very young one is labelled 'Mediterranean'; but this locality is highly improbable. The specimen from the Red Sea and one without locality were labelled *P. dubia*.

The specimen from Ceylon is one of the finest, with the test 68×45 mm. and the primary spines 85-95 mm. long; there are only 6 coronal plates. Other specimens have 7 or even 8 coronal plates. The test of the smallest specimen is 18 mm. in diameter and the primary spines are 23 mm. long by 3 mm. in diameter; the primaries are encircled 5-6 mm. from the tip by either a whitish band, 1.5 mm. wide, or by two narrow white bands separated by an area of pale lavender. In some of the larger specimens bands occur near the tip of certain primaries, but even when present they are usually rather faint. The specimen from Lifu has very stout primaries with 1, 2 or 3 pale bands distally.

1 a. *P. imperialis* var. *parvispina*.

Phyllacanthus parvispina Tenison-Woods, 1879. *Proc. Linn. Soc. N.S.W.*, 4, p. 286, pl. XIV.

Primary spines slender, nearly cylindrical.

5 specimens, of which 4 are without locality, and the fifth is from Port Jackson, N.S.W.

Examination of these specimens, taken in connexion with that of the 23 specimens of typical *P. imperialis* listed above, and with renewed examination of the 25 specimens in the Museum of Comparative Zoölogy, has not led me to believe that *parrispina* is a valid species. I even doubt whether it is a natural variety. The other varieties of *imperialis* (*dubia*, *fustigera*) recognized by Döderlein (1903, *Denkschr. Ges. Jena*, 8, p. 691) seem to me even less satisfactory.

2. CHONDROCIDARIS.

A. Agassiz, 1863. *Bull. M.C.Z.*, 1, p. 18.

Type, *Chondrocidaris gigantea* A. Agassiz, 1863. *Bull. M.C.Z.*, 1, p. 18.

Pores horizontal, distant, connected by a shallow groove; median interambulacral areas very wide, densely covered with minute tubercles; primary spines very conspicuously provided with thorns, knobs and ridges.

1. *Chondrocidaris brevispina* sp. nov. PLATE I, figs. 1 and 2.

Test somewhat flattened, 54 mm. in horizontal diameter and 33 mm. high. Primary spines 40–45 mm. long. Test and small spines much as in *C. gigantea*, but all spines are markedly papillose, when seen under a lens. Coronal plates 6 or 7 in a column. Abactinal system 22 mm. in diameter, with the ocular plates small and apparently all exsert. Actinostome 27 mm. across. Primary spines remarkable for the greatly developed collar; thus a primary 40 mm. long has the collar 15 mm. high and 7.5 mm. in diameter. Beyond the collar the spine attenuates to a blunt point very rapidly, but is covered with irregular outgrowths and bluntly pointed tubercles, often more or less encrusted with a sponge. No tridentate or large globiferous pedicellariae were found; the small globiferous are very small, fairly numerous, and not peculiar.

Colour, olive-yellow, greener on secondary spines and quite green on peristome; milled ring of primaries olive-yellow, collar dark olive, at base olive-yellow; rest of spine coral red (as is the encrusting sponge); on the younger primaries the collar is distinctly dull red rather than olive.

Loyalty Islands, Lifu (*Willey*).

This superb specimen of a very well-marked new species is labelled *Phyllacanthus gigantea*, and is recorded by Bell (1899, *Willey's Zool. Res.*, pt. ii, p. 135) under that name, almost without comment. It is easily distinguished from *P. gigantea* by the remarkable primary spines.

2. *Chondrocidaris gigantea*.

A. Agassiz, 1863. *Bull. M.C.Z.*, 1, p. 18. 1873, *Rev. Ech.*, pt. 3, pl. 1a.

Primary spines long, richly provided with thorns and ridges, and with a low, inconspicuous collar.

4 specimens, of which 2 are from Mauritius and 2 from the Hawaiian Islands, 'off Honolulu Reefs' (*Challenger*).

The specimens from Mauritius are smaller and much brighter in colour than the Hawaiian individuals, and have the primary spines provided with conspicuous thorn-like projections (4 mm. high and 3 mm. in diameter basally) in about 8 irregular, alternating series. The ridges so characteristic of the distal part of the spines in the Hawaiian specimens are seldom developed in those from Mauritius, which have the test, small spines and pedicellariae cream-yellow, with the terminal half of the secondaries red (tending to light vermillion); the collars of the primaries are also red with numerous faint spots of a darker shade. In the Hawaiian specimens the colours are dingy yellow and brown-red. The colour difference is so striking that I was at first inclined to

regard the Mauritius form as a distinct species, but subsequent comparison of the specimens convinced me of their specific identity. The smaller Mauritian specimen is only 35 mm. in diameter and has but 5 coronal plates in a column, whereas the larger is 63 mm. through and has 8 coronal plates. The Hawaiian specimens are 85 mm. in diameter and 50–52 mm. high, with primary spines 100–110 mm. long and 6 mm. in diameter. The primaries are encrusted with a great variety of invertebrates.

3. PRIONOCIDARIS.

A. Agassiz, 1863. Bull. M.C.Z., 1, p. 18.

Type, *Cidarites pistillaris* Lamarck = *Cidarites baculosa* Lamarck, 1816. Anim. s. Vert. 3, p. 55.

Pores horizontal, distant, connected by a shallow groove; some primary spines with thorns at least near base, or collar spotted; interambulacral areas narrow.

1. *Prionocidaris australis*.

Phyllacanthus australis Ramsay, 1885. Cat. Ech. Austral. Mus., p. 44, pls. I, I a and b.

Prionocidaris australis H. L. Clark, 1916. Endeavour Rep., p. 97.

Collar of primary spines with numerous small white spots.

10 specimens, all young, from 3 stations on Macclesfield Bank at depths of 28–46 fms. All were labelled '*Phyllacanthus baculosa*'.

The occurrence of this species on Macclesfield Bank is of no little interest, for authentic specimens were known hitherto only from the east coast of Australia and from Malacca. The white spots on the collar of the primary spines, so characteristic of the species, are well shown by all these young specimens.

2. *Prionocidaris baculosa*.

Cidarites baculosa Lamarck, 1816. Anim. s. Vert., 3, p. 55.

Prionocidaris baculosa Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., p. 50. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. I f, figs. 4 and 5 (as *Phyllacanthus baculosa*).

Primary spines exceedingly diverse, but always with spots of purple on the collars of those fully formed.

93 specimens, of which 3 are bare tests and 15 are without locality. Localities represented are: Indian Seas; Red Sea; Aden; Muscat; Mekran Coast (*F. W. Townsend*); Kurachee; East Coast of Africa; British East Africa, Wasini Island, 10 fms. (*Crossland*); German East Africa; Mozambique (*Alert*); Amirante Islands, 25–50 fms. (*Gardiner*); Amirantes, Ile des Roches and Ile des Neufs (*Gardiner*); Mauritius; Saya de Malha Bank, 150 fms. (*Gardiner*); Chagos Archipelago, Peros Banhos, Ile du Coin (*Gardiner*); Madras; Singapore; East Indies; Japan, Uraga Channel;

Macclesfield Bank, 30-46 fms.; Parry Shoal, 12 fms.; Philippine Islands, Zamboanga (*Challenger*); Dutch East Indies, Damma Island, 9-15 fms. One of the specimens without locality was labelled *Dorocidaris papillata*; the three from 'Indian Seas', 'German East Africa', and the 'East Indies' were labelled *Stephanocidaris bispinosa*; one from Mozambique and another from Ile des Neufs were labelled *Cidaris metularia*.

This magnificent series of specimens well exhibits the great diversity shown by this species. The specimens range in size from young ones only 7 mm. in test diameter to adults 68 mm. through. In young specimens and in most of those half-grown the primaries are longer than the horizontal diameter of the test, and are often twice as much or a little more, but in adults the spines are relatively much shorter; in the specimens 68 mm. in diameter the primary spines are 40-50 mm. long. The primaries are usually more or less thorny, and are generally widened near the base; in a fine specimen from Mauritius, 35 mm. through, the primaries are 75 mm. long and 6 mm. wide near base. In the specimen from Aden, however, the spines are neither thorny nor flattened; they are 32-42 mm. long, 6 mm. in diameter, and often somewhat flaring at tip. The two specimens from Saya de Malha have nearly terete primaries, 55-60 mm. long, without thorns but finely prickly, with no conspicuous difference between the upper and lower sides; these specimens, moreover, are very dark coloured—red-brown with a purplish tinge.

The specimen from Mozambique labelled *Cidaris metularia* was taken by the *Alert*: it has short stout spines with low collars on which the characteristic purple spots are more or less merged together; it is obviously an old individual. The specimen from the Uraga Channel is notable, not merely for the new locality, but for the handsome primary spines, which are basally flattened and have conspicuously serrate margins with 10-12 white teeth on each side; on the upper surface are 3 series of white, sharp tubercles, and on the lower side are about a dozen close-set series of similar but smaller tubercles. The ground colour of the spine is brownish, and the distal half is more or less clearly banded with purple. A young specimen from Muscat only 15 mm. in diameter has primary spines 35 mm. long, very similar to those of the Japanese specimen, but the coarse white teeth of the upper side are grouped into transverse bands which make the spines when seen from above appear verticillate; there are 6 of these bands on the longest spines. The specimen from Muscat has somewhat similar primaries. The tendency to verticillate primary spines reaches an extreme in one of the specimens from an unknown locality. This individual is 38 mm. in

diameter and 23 mm. high, and the primary spines are only about 30 mm. long. They are as verticillate as in *P. verticillata*, having 3-5 whorls of blunt projections, but the collars have the characteristic purple spots. Moreover, the ambulacra are only 6 mm. wide and the interambulacra are fully 18 mm. Unfortunately no globiferous pedicellariae could be found.

Young individuals of *P. baculosa* are usually bright coloured, much more so than most adults, and they may easily be confused with young *Stylocidaris bracteata*, in which the primaries are generally conspicuously banded. Careful comparison of the ambulacra will usually enable the two species to be distinguished, unless the specimens be very small. Moreover, in *P. baculosa* the collar spots are *purple*, but in *S. bracteata* they are *crimson*. Unfortunately the pedicellariae help very little to distinguish the two species.

2 a. *P. baculosa* var. *lineata* var. nov.

3 specimens, of which one is without locality, one is from the Seychelles, and one is from Natal, off Umhlangakulu River 7½ miles.

These are all small, 11-19 mm. in diameter, but the primary spines have their collars marked with longitudinal lines of purple, instead of spots. This type of coloration has long been known, and it has sometimes been suggested that it is this form which Lamarek named *pistillaris*. Possibly the words 'collo-suleatis' and 'silloné' (used in his comment on *P. baculosa*) might be construed as referring to the coloration, but that seems quite improbable, and as no type-specimen of *P. pistillaris* exists, it seems to me that the name should be ignored. Hence I have selected the name *lineata* for this well-marked form, which may prove to be a distinct species, or at least a geographical subspecies, for all the specimens that I know of are from the east coast of Africa south of Mozambique or from the neighbouring islands, and all the specimens of *Prionocidaris* from that region that I have seen belong to this variety.

3. *Prionocidaris badia* sp. nov. PLATE II, fig. 2.

Test somewhat flattened, 27 mm. in diameter and 17 mm. high, apparently not essentially different from that of *P. bispinosa*. Abactinal system 13 mm. in diameter and actinostome the same. Primary spines 90 mm. long and 5 mm. in diameter at base, with about a dozen series of sharp thorns, one millimetre high proximally, but becoming low and blunt and finally disappearing at the bluntly pointed (rarely truncate or slightly flaring) tip of spine. Collar very low, only 1-1.5 mm. high. Oral primaries slender, bluntly pointed, with 6-8 longitudinal ridges especially marked near the tip.

No globiferous pedicellariae were found. Tridentate pedicellariae numerous, variable in size, very slender; the larger they are the more slender the valves; the largest have valves 1.5 mm. long or more.

General coloration brown; primary spines brown or grey-brown, the distal half more or less indistinctly banded with a darker shade; undeveloped abactinal primaries faintly striated longitudinally with light brown and brownish-white; collar deep yellowish-brown without markings of any kind; secondary and miliary spines rich red-brown with a purplish tinge.

Mauritius (*Robillard*). 2 specimens.

This is the sea-urchin which de Loriol (1883, *Mém. Soc. Phys. Genève*, **28**, No. 8, p. 6, pl. I, fig. 1) carefully described and figured as a form of *P. baculosa*. His material consisted of two specimens, also collected by M. Robillard. Because he could find no difference whatever between the tests of these brown specimens and of specimens of *P. baculosa* of the same size, de Loriol considered that this form was not worthy of recognition as a distinct species or even as a named variety.

In my opinion these Mauritian specimens are much nearer to *P. bispinosa* than they are to *P. baculosa*, but they are obviously and apparently constantly (to judge from four adult specimens) distinct from either. Among all the great variety of specimens of *Prionocidaris* which I have examined I have never seen any that approached these in general form and coloration. The specimen I have selected for the holotype was labelled '*Phyllacanthus baculosa* var. *longispina*. 88.1.99.11. Mauritius', and the paratype was labelled '*Cidaritis baculosa*. 91.1.2.1. Mauritius'. Both are dry specimens.

4. *Prionocidaris bispinosa*.

Cidarites bispinosa Lamarek, 1816. *Anim. s. Vert.*, **3**, p. 57.

Prionocidaris bispinosa Döderlein, 1911. *Abh. Senck. Nat. Ges.*, **34**, p. 240. 1903. *Denkschr. Ges. Jena*, **8**, pl. LVIII, figs. 5-11 (as *Leiocidaris bispinosa*).

Collar low, rose-red, pinkish, red-brown or brown, quite without spots or lines; primaries varying from smooth, with scarcely any thorns, or none, to very thorny, but never with longitudinal series of small thorns or serrations.

44 specimens. Localities represented are: Singapore; East Indies; Billiton; St. 186, Torres Strait, 8 fms. (*Challenger*); Prince of Wales Channel, 7 fms., sand (*Alert*); Thursday Island; Albany Island; Queensland, Port Molle, 14 fms. (*Alert*); Port Curtis, 5-11 fms. (*Alert*); North Australia, Port Darwin, 8-12 fms., sand (*Alert*); Holothuria Bank,

15 fms. and 36 fms.; West Australia; North-west Australia, Baudin Island; Cossack, Magnetic Shoal; Dampier Archipelago, Lewis Island. Most of these specimens were labelled *Phyllacanthus annulifera*, but two from the 'East Indies' were labelled *P. baculosa*.

This is a fascinating series of young and adult specimens from 10 to 58 mm. in diameter, showing the greatest diversity in the character of the primary spines, so great even among specimens from one locality that I am unable to delimit satisfactorily the varieties that have already been named, and I doubt if constant varieties have as yet been distinguished. Thus, among the dozen specimens taken at 15 fms. on Holothuria Bank, one large adult has all the primaries terete and smooth, yellowish, banded with greenish-brown or purplish, but 3 other specimens have the thorniest primaries of any specimens in the collection, with many of the thorns 4-5 mm. long, sharp and often a bit curved; these primaries are more or less flaring at tip. The two largest individuals approach the extreme with terete or cylindrical smooth spines; others have the primaries moderately thorny as in typical specimens. The most perplexing feature of the specimens with smooth spines is that the collars show a few irregular crimson spots like those of *Stylocidaris bracteata*. As the latter species occurs at Holothuria Bank, it is possible that hybridization has occurred, but more data are needed before we can affirm this.

The two specimens labelled simply 'East Indies' are about 33 mm. in diameter, with the primary spines only 20-25 mm. long and 4 mm. in diameter at base; the primaries are very thorny, some of the thorns 3-4 mm. long. Their colour is white with a greenish or lavender tinge, blotched here and there with rose-purple; the milled ring is rose colour, and the collar bright, unspotted rose-purple or pink-lavender. The secondary spines are pale green or nearly white, those of the ambulacra with dark bases; these are the two handsomest specimens in the series.

The collar varies a good deal in colour, ranging from dull yellowish or even orange to lavender, rose or brown, but, excepting only the specimens from Holothuria Bank already mentioned, it is always without spots or markings of any kind. The secondaries show an even greater range of colour, those of the ambulacra being often, perhaps usually, darker than those on the interambulacra; in the specimen from Singapore the interambulacral secondaries are drab, becoming greenish at tip, while those of the ambulacra are almost black, though somewhat lighter distally.

The two specimens from Billiton seem to have been selected to illustrate extremes of variation. One, 50 mm. in diameter,

has the primary spines only about 40 mm. long, 4 or 5 mm. thick at base, very thorny, blunt and often flaring at tip. The other is 40 mm. in diameter with the primaries 70 mm. long, only 3 mm. thick at base, and with but a few thorns near base or at tip. The coloration of these specimens is not peculiar.

5. *Prionocidaris verticillata*.

Cidarites verticillata Lamarek, 1816. Anim. s. Vert., 3, p. 56.

Prionocidaris verticillata Döderlein, 1911. Abh. Senck. Nat. Ges., 34, p. 243. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. I f, fig. 3 (as *Phyllacanthus verticillata*).

Primary spines with unspotted collar, but with 2 or 3 whorls of projecting ridges; more or less green in coloration.

15 specimens, 3 without locality. Localities represented are: British East Africa, Wasin, 10 fms. (*Crossland*); Zanzibar; Mauritius; Chagos Archipelago, Peros Banhos, Ile du Coin (*Gardiner*); Chagos Archipelago, Egmont Island (*Gardiner*); Andaman Islands; Philippine Islands, Mindoro; Samoa. The specimen from Egmont Island was labelled *Phyllacanthus annulifera*.

The specimen from the Andaman Islands is the finest I have ever seen; it is 33 mm. in diameter and the primary spines are 35–38 mm. long; there are 3 whorls of 9–11 projections, on each spine, the basal whorl being the largest, 8–9 mm. across; the spine is 5 mm. in thickness below this whorl. The specimens from Wasin (2), Zanzibar (1) and Egmont (2) are also notably fine, but are hardly half as large.

4. CIDARIS.

Leske, 1778. Add. ad Klein, pp. xvii and 61.

Type, *Cidaris papillata* Leske = *Echinus cidaris* Linné, 1758. Sys. Nat., ed. 10, p. 664, as limited in 1761, Fauna Suecica, ed. II, p. 513.

Pores near together, more or less oblique; globiferous pedicellariae present, large ones with an end tooth; ambulacra and primary spines not peculiar: abactinal system not sharply defined, rather irregular in outline.

1. *Cidaris abyssicola*.

Dorocidaris abyssicola A. Agassiz, 1869. Bull. M.C.Z., 1, p. 253.

1872, Rev. Ech., pt. 1, pl. I, figs. 1–4.

Cidaris abyssicola Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., p. 54.

Median ambulacral area narrow, covered with small tubercles; primary spines white and more or less smooth.

2 specimens from Florida, off Sand Key, 195 fms., labelled *Dorocidaris papillata*.

These are typical examples from the material collected by Count Pourtales in the spring of 1868 and identified by Agassiz.

2. *Cidaris blakei*.

Dorocidaris blakei A. Agassiz, 1878. Bull. M.C.Z., 5, p. 185. 1883, Mem. M.C.Z., 10, No. 1., pl. 1.

Cidaris blakei Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., p. 54.

Primary spines often more or less expanded and flattened distally: each coronal plate with numerous tubercles on its inner half; sutural line distinct.

1 specimen from off Santa Cruz, 248 fms.

This is a superb adult specimen, taken by the *Blake* at Station 134, on a bottom of coarse sand and broken shells, in the winter of 1878-9.

3. *Cidaris cidaris*.

Echinus cidaris Linné, 1758. Sys. Nat., ed. X, p. 664. 1761, Fauna Suecica, ed. II, p. 513.

Cidaris cidaris Bather, 1908. Ann. Mag. Nat. Hist. (8), 6, p. 288. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. 1 b (as *Dorocidaris papillata*).

Each coronal plate with only a few tubercles on inner half; primary spines long, cylindrical or terete, with low, finely serrate longitudinal ridges.

32 specimens, of which 3 are bare tests and 11 are without locality. Localities represented are: Lousy Bank, 60° 19' N., 12° 36' W., 100-200 fms.; S.E. England; 'between 49° and 50° N. and about 11° W., 200-400 fms.'; Ireland, off Wexford, 30-40 fms. (*Porcupine*); Ireland, 45 miles off Blackrock, 500 fms.; 36° N. × 70° W., 400 fms.; Atlantic, St. Paul's Rocks (*Challenger*); Mediterranean; Naples; Malta; Adventure Bank.

There are some fine examples of this well-known species in the present series, the specimens from Lousy Bank and from 49° or 50° N. × 11° W. being particularly notable. The largest specimen is a bare test from 'S.E. England': this is 63 mm. in diameter and 59 mm. high; the height is thus much greater in proportion to the diameter than is usual in the genus, and there are 9 (possibly 10 in one or two columns) coronal plates; oculars I, IV and V are insert; the abactinal system and peristome are each about 25 mm. across. Another notable specimen is that which is supposed to be from the western Atlantic (36° N. × 70° W.). Primary spines are no longer attached to the test, but there are half a dozen in the jar with it; the test is 45 × 34 mm. and these spines are 25-60 mm. long; they are remarkably smooth, but one (48 mm. long by 3.5 mm. thick) has longitudinal ridges, which are more or less notched into teeth, although the spine scarcely feels rough.

The *Challenger* specimen from St. Paul's Rocks was correctly identified by Agassiz, and my suggestion (1907, Bull. M.C.Z., 51, p. 209) that it might prove to be *C. rugosa* is

not supported by examination of the specimen. Mortensen (1903, *Ingolf* Ech., pt. 1, p. 170) has also seen it and expressed his belief that it is the present species. There seems no reason to doubt therefore that the species occurs south of the Equator.

4. *Cidaris micans*.

Dorocidaris micans Mortensen, 1903. *Ingolf* Ech., pt. I, p. 23. 1910, Bull. U.S. Nat. Mus., 74, pl. I.

Very handsome, white, rose colour and green; primaries highly polished, like porcelain.

1 specimen from Cuba, off Havana, 184 fms., *Albatross* Station 2345.

This is the holotype of the species; the test is 27 mm. in diameter, and the longest primaries are 57 mm. long.

5. *Cidaris rugosa*.

Dorocidaris rugosa H. L. Clark, 1907. Bull. M.C.Z., 51, p. 210, pls. IV, V and VII, figs. 4-8.

Cidaris rugosa Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., p. 54.

Similar to *C. cidaris*, but primary spines stouter and more prickly, and test more fully covered with tubercles.

2 specimens without locality, one bare.

These specimens add little to our knowledge of the species. The one with spines is 40 mm. in diameter but is in poor condition, and appears to have been taken from a fish's stomach. It may possibly be *C. cidaris*, but the primary spines are much more like those of *C. rugosa*, stout and very prickly.

5. TRETOCIDARIS.

Mortensen, 1903. *Ingolf* Ech., pt. I, p. 16.

Type, *Dorocidaris bartletti* A. Agassiz, 1880. Bull. M.C.Z., 8, p. 69.

Like *Cidaris*, but abactinal system sharply defined; primary spines thorny or else flaring at tip; globiferous pedicellariae with a mere pore at the tip of each valve, just below end-tooth.

1. *Tretocidaris bartletti*.

Dorocidaris bartletti A. Agassiz, 1880. Bull. M.C.Z., 8, p. 69.

Tretocidaris bartletti Mortensen, 1903. *Ingolf* Ech., pt. I, p. 16. 1910, Bull. U.S. Nat. Mus., 74, pls. II and III.

Primary spines thorny and variegated.

1 specimen from the 'West Indies'.

This is a very fine example of *T. bartletti*, although it is the type of Mortensen's *T. annulata*. Dr. Mortensen, who had been misled as to the characters of *T. bartletti* by a wrongly

named figure in the *Blake* report, later suggested that *T. annulata* was identical with *T. bartletti*.

2. *Tretocidaris spinosa*.

Mortensen, 1903. *Ingolf* Ech., pt. I, p. 17. Koehler, 1908. Trans. Roy. Soc. Edinburgh, **46**, pl. XVI, figs. 163 and 164. (These figures fail to show the remarkable primary spines.)

Primary spines stout, not thorny, conspicuously flaring at tip. 1 specimen from St. Helena.

This is the holotype of the species. It is 49 mm. in diameter and 33 mm. high with 9 coronal plates in each column. The abactinal system and actinostome are each about 22 mm. across. The primary spines are really extraordinary, 45–60 mm. long: a typical one is 48 mm. long, 4 mm. in thickness at the base, and 6 mm. across at the tip. The test has a light greenish tinge and the small spines are brown-red, darkest at the tips. The collar of the primary spines is pale orange-red, and the neck is purplish with faint longitudinal whitish lines. The differences from *T. bartletti* in the form of the primary spines and in the colour are very striking.

6. EUCIDARIS.

Pomel, 1883. Class. Meth. Ech., p. 109.

Type, *Cidarites metularia* Lamarck, 1816. Anim. s. Vert., **3**, p. 56.

Primaries short, stout, not thorny: globiferous pedicellariae without an end-tooth on the valves: abactinal system sharply defined; araeolae little or not at all sunken.

1. *Eucidaris metularia*.

Cidarites metularia Lamarck, 1816. Anim. s. Vert., **3**, p. 56.

Eucidaris metularia Döderlein, 1887. Jap. Seeigel, p. 42. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. I g, fig. 1 (as *Cidaris metularia*).

Size small; coronal plates 5 or 6, rarely 7: median ambulacral areas wide and bare.

87 specimens, 11 without locality. Localities represented are: Gulf of Suez; Red Sea; Red Sea, Daedalus Shoal; British East Africa, Wasin, 10 fms. (*Crossland*); Zanzibar (*Crossland*); German East Africa; Cape of Good Hope; Amirante Islands, 25–50 fms. (*Gardiner*); Amirantes, Marie Louise Island (*Alert*); Mauritius; Chagos Archipelago, Salomon Atoll, 60–120 fms. (*Gardiner*); Maldives, Male, Hulule (*Gardiner*); Macclesfield Bank, 10–44 fms.; Cape Belcher; Australia; North Australia, Evans Bank, 12–15 fms.; Flinders Bank, 9 fms.; New Britain (*Willey*); New Hebrides, Port Patterson; Minerva Reefs; Rotuma; Sandwich Islands.—The specimen labelled 'Cape of Good Hope' was received in 1840, and is the basis for giving that

locality for this species; as *E. metularia* has not otherwise been reported from south of Mozambique, it is unlikely that this label is to be trusted. The specimen from Salomon Bank was labelled '*Coelopleurus yg*'.

Although *E. metularia* has so wide a range, it is not a variable species, and this series shows little diversity. Some of the specimens without locality have remarkably thick primary spines, comparable possibly to the stout primaries of *E. thouarsii* var. *galapagensis*, but not so marked.

Young specimens are notable for their pretty coloration. The abactinal part of the test is bright red, somewhat rosy, the ambulacral secondaries are bright red, tending to vermillion, the interambulacral secondaries are yellow-green, and the primary spines are pale with dark bands, often pale red with bands of a darker shade.

2. *Eucidaris thouarsii*.

Cidarites thouarsii Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 326.

Eucidaris thouarsii Döderlein, 1887. Jap. Seeigel, p. 42, pl. X (as *E. galapagensis*).

Rather large and heavy; dark coloured; ambulacral and interambulacral areas narrow, not bare.

15 specimens, 3 without locality. Localities represented are: Gulf of California; coast of Nicaragua; Panama; Galapagos Islands, Charles Island; Galapagos, Abingdon Island.

The specimen from Charles Island is a typical example of the form distinguished by Döderlein under the name *E. galapagensis*, but the 5 examples from Abingdon Island are more like the normal *E. thouarsii*; the largest is 65 mm. in diameter and has spines 60 mm. long; their diameter is only 5 mm., but encrusted as they are with sponges they appear to be 7–10 mm. thick. Consideration of all the specimens of *E. thouarsii* that I have seen makes me hesitate to recognize *galapagensis* as a valid variety.

3. *Eucidaris tribuloides*.

Cidarites tribuloides Lamarek, 1816. Anim. s. Vert., 3, p. 56.

A. Agassiz, 1872. Rev. Ech., pt. I, pl. I d, and pl. II, figs. 1–3 (as *Cidarites tribuloides*).

Eucidaris tribuloides Döderlein, 1887. Jap. Seeigel, p. 42.

Moderate to large, rather light coloured; median interambulacral area moderately wide; abactinal system rather large, its diameter over 0.40 of test diameter, as a rule.

84 specimens, of which 6 are bare and 32 have no locality label. Localities represented are: Turks Island; St. Vincent¹; Swan Island; Fernando Noronha (*Challenger*);

¹ Probably this is St. Vincent in the Cape Verde Islands and not the West Indian island.

Brazil, Bahia (*Challenger*); Ascension Island (*Courry*); Cape Verde Islands (*Alert*); St. Vincent; St. Helena. A specimen is labelled 'Port Adelaide, South Australia', but obviously this is a mistake. One of the specimens without locality was labelled *Phyllacanthus imperialis*; those from Ascension were labelled *Cidaris metularia*.

The absence of specimens from the West Indies is the most surprising thing about this series, and owing to this it was not possible to make a critical comparison of the material from the Cape Verde Islands and from St. Helena with West Indian examples. But after examination of the numerous West Indian *E. tribuloides* in the Museum of Comparative Zoölogy, and study of the Cape Verde and St. Helena material in the British Museum, I am unable to agree with Mortensen that the form found in the eastern Atlantic is uniformly recognizably different from the West Indian and Brazilian form. A much more conspicuous variety occurs, especially in the St. Helena material, notable for its very stout spines, like the variety *galapagensis* of *E. thouarsii*. A young specimen from St. Helena about 10 mm. in diameter has primary spines less than 12 mm. long, 4.5 mm. thick at tip, but less than 2 mm. in diameter at the base. A specimen from Ascension with test 22 mm. in diameter has spines 20 mm. long and 5 mm. in diameter, and a specimen from St. Helena, 30 mm. in diameter, has the primaries about 30 by 7 mm. But the stoutest spines occur on a somewhat smaller specimen from an unknown locality, which has spines 25 mm. long and 8 mm. thick just below the rounded tip. These stout-spined specimens however are not from any one locality, nor do all the specimens from St. Helena possess such spines.

Some of the specimens from St. Vincent, Cape Verde, were collected in 1904 by Cyril Crossland, whose original label says they were 'dredged in great abundance in 10 fms. or so'. They have much shorter and stouter spines than the very typical specimen taken by the *Alert* at the same place on 'sand' in '6-12 fms.'

Two of the *Challenger* specimens from Bahia are young, olive-green in colour, with conspicuously thorny spines. They remind one of *Cidaris minor* Koehler, and in my judgement make the validity of that species dubious. It may be added that genital pores can be distinguished in young *E. tribuloides* when they are about 10 mm. in diameter.

7. STYLOCIDARIS.

Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., p. 52.

Type, *Cidaris affinis* Philippi, 1845. Arch. f. Naturg., 11 (1), p. 351.

Similar to *Eucidaris*, but primary spines long and slender, and araeolae more or less deeply sunken.

1. *Stylocidaris affinis*.

Cidaris affinis Philippi, 1845. Arch. f. Naturg., 11 (1), p. 351.

Mortensen, 1903. Ingolf Ech., pl. I, fig. 1.

Stylocidaris affinis Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., p. 52. A. Agassiz, 1872. Rev. Ech., pt. 1, pl. I, fig. 5.

Test moderately flattened; median ambulacral and interambulacral areas more or less bare; abactinal system large; primaries slender, terete, with longitudinal series of numerous minute prickles.

32 specimens, of which 3 lack spines and 14 are without locality. Localities represented are: Adventure Bank; Mediterranean; France; Nice; Naples; Malta; Madeira. The specimen from Madeira and one without locality were labelled *Goniocidaris tubaria*. Most of the others were labelled *Dorocidaris papillata*.

The absence of West Indian specimens is an unfortunate feature of this series, but some of the Mediterranean specimens are very fine. The specimen from Nice is larger than any individual yet recorded, as it is 42 mm. in diameter, 30 mm. high, and has primary spines 57 mm. long by 3 mm. thick. The colours however are dull.

2. *Stylocidaris bracteata*.

Dorocidaris bracteata A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 197.

Stylocidaris bracteata Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., p. 52. H. L. Clark, 1907. Bull. M.C.Z., 51, pl. X, figs. 1 and 2 (as *Tretocidaris bracteata*).

Abactinal system larger than peristome; median areas not bare; primary spines sometimes flattened at base, with about 10 longitudinal ridges, which may be finely serrate.

10 specimens, of which 1 has no locality label. Localities represented are: Amirante Islands, 34 fms. (*Gardiner*); Macclesfield Bank, 23-40 fms.; Amboina, 15-25 fms. (*Challenger*); Holothuria Bank, 36 fms.; Arafura Sea, Parry Shoal. The specimen without locality was labelled *Stephanocidaris bispinosa*, one from Macclesfield Bank and the one from Parry Shoal were labelled *Cidaris baculosa*, and two from Holothuria Bank were named *Cidaris annulifera*.

The three Amboina specimens are the types of the species and are in very fine condition; the best is 28 mm. in diameter and has primary spines 75 mm. long. All of the other specimens are quite young and there is room for doubt as to their identity. The crimson spots on the collar of the primaries is a very distinctive mark, but in young *Prionocidaris baculosa* the purple dots are often quite reddish, so that care must be used in distinguishing these two species in young material.

2a. *S. bracteata* var. *albidens* var. nov.

2 specimens from Ceylon, west of Kaltusa (*Herdman*), and from Macclesfield Bank, 55-60 fms.

These two specimens agree in the character of the primary

spines and, to a lesser degree, in the coloration, and it may be convenient to have a name for the form. The Macclesfield Bank specimen is more olive than the one from Ceylon and the abactinal system, ambulacral secondaries and primary spines are much lighter. In the Ceylon specimen the primaries are brown, faintly banded with darker, but they are pale olive in the other; in both the 'thorns' are pure white, and the collar, which is quite low, is whitish with brown longitudinal stripes; these brown stripes are continuous with the brown furrows of the spine itself, between the series of white thorns, the latter being continuous with the lighter stripes of the collar. The larger specimen, from Ceylon, is 20 mm. in diameter, and the handsome primaries are 35-40 mm. long.

3. *Stylocidaris panamensis*.

Dorocidaris panamensis A. Agassiz, 1898. Bull. M.C.Z., 32, p. 73; 1904, Mem. M.C.Z., 31, pls. I and II.

Stylocidaris panamensis Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., p. 52.

Test much flattened; primaries reddish, very slender; collar and secondaries dark, uniform brownish-red.

1 specimen from the Eastern Pacific, off Cocos Island, 100 fms., Albatross Station 3367.

This is one of Agassiz's types and an excellent representative of the species.

4. *Stylocidaris reini*.

Cidaris (Dorocidaris) reini Döderlein, 1887. Jap. Seeigel, p. 7, pl. IV, figs. 1-7.

Stylocidaris reini Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., p. 52.

Abactinal system larger than peristome; median areas not bare; primary spines long and terete, with 12-15 series of fine, sharp granules.

4 specimens, of which 1, labelled *Dorocidaris papillata*, is from Japan, Misaki; 1, labelled *Goniocidaris florigera*, is also from Misaki (*Insole*); 1, labelled *Dorocidaris papillata*, is from St. 204, Philippine Islands, east of Mindoro, 100-115 fms. (*Challenger*); and 1, labelled *Phyllacanthus annulifera*, is from New Britain (*Willey*).

The *Insole* specimen from Misaki is small and nearly white, though the genitals show some red-brown and there is a spot of similar colour on each ocular. The other specimen from Misaki is much larger, and shows the usual coloration; it is 28 mm. in diameter and has primary spines 58 mm. long. The *Challenger* specimen is rather light coloured, as the primaries are dirty white and the small spines are pale-greenish with a median longitudinal stripe of darker green; the

genital plates, however, are a deep brown-red. The specimen from New Britain is notable not only for its locality, which is considerably south-east of the previously known range, but for its fine coloration; the primaries, where not encrusted, are nearly white; the genital and anal plates are dark red-brown; the interambulacral secondaries are greenish-white with a broad longitudinal dark stripe; ambulacral secondaries are similar but with the longitudinal stripe much narrower; oculars greenish-white; test 30 mm. in diameter and primaries 65×3 mm.

As shown by the labels, this species has been generally overlooked, but apparently is not rare in Japanese and East Indian seas. The New Britain specimen was recorded by Bell in 1899 (Willey's Zool. Res., pt. II, p. 134) as having the spines 'when fresh' 'quite covered with an encrusting Zoanthid'; this encrusting is still conspicuous.

8. STEREOCIDARIS.

Pomel, 1883. Class. Meth. Ech., p. 110.

Type, *Cidaris cretosa* Mantell, 1835. Trans. Geol. Soc. London (2) 3, p. 205.

Uppermost coronal plates without primary spines, as a rule, though tubercles may be present; abactinal system with irregular outline, not sharply defined; genital pores small; test rather solid; primary spines very diverse.

1. *Stereocidaris capensis*.

Stereocidaris indica var. *capensis* Döderlein, 1901. Zool. Anz., 23, p. 19.

Stereocidaris capensis Döderlein, 1906. *Valdivia* Ech., p. 110, pl. X, figs. 3-6.

Primary spines $1.5-2 \times$ the diameter of test, rather stout, the thickness about 0.10 of length; actinostome notably small.

2 specimens, from the Cape of Good Hope, off East London, 250-303 fms., and from Natal, off Umhlangakulu River, 50 fms.

The East London specimen is 30 mm. in diameter and 22 mm. high; the abactinal system is 17 mm. across, but the actinostome is only 12; the primary spines, 60 mm. long by 3.5 mm. in diameter near base, are beautifully terete, prickly but not ridged; the collar is brownish-purple with the neck white or pink; the secondaries of the scrobicular circle are greyish-lavender, but the specimen is badly rust-stained. Actinal primaries near mouth very slender and rather smooth, the lowest perfectly smooth; one or frequently two upper coronal plates in each column lack primary spines, but the second has a large imperforate tubercle. This specimen is

evidently nearer to *S. indica* than it is to *S. capensis*, further evidence that these two nominal species are identical.

The Natal specimen is 50 mm. in diameter and 32 mm. high. The abactinal system is 24 mm. across and the actinostome is 22. Only the uppermost coronal plate in each column lacks a primary spine. These spines are 60 mm. long and 4 mm. in diameter, without 'wings' or ridges. The collar is lavender and the neck white. The secondaries of the scrobicular rings are grey, rarely with darker tips or a dark spot near tip. This individual also is nearer to *S. indica* than to typical *S. capensis*.

2. *Stereocidaris grandis*.

Dorocidaris grandis Döderlein, 1885. Arch. f. Naturg., 51 (1), p. 77.
Stereocidaris grandis Döderlein, 1887. Jap. Seeigel, p. 42, pl. 1.

Primaries cylindrical; ambulacra rather wide; secondaries not white; actinostome smaller than abactinal system; whole abactinal surface appears quite bare.

2 specimens, from Japan, Misaki, and from *Challenger* St. 210, Philippine Islands, north of Mindanao, 375 fms., mud; labelled *Dorocidaris papillata*.

These specimens are only about half grown; it is not quite certain that they belong to this species. There is little doubt about the specimen from Misaki, but the Philippine specimen is more dubious. This is 30 mm. in diameter, with the abactinal system 15 mm. across, and the actinostome only 10. The primary spines are 60 mm. long and only 2.5 mm. in diameter; they are nearly white, with very pink necks and light brown collars; the pink extends well out on the spine; the general colour of test and small spines is dull yellowish.

3. *Stereocidaris ingolfiana*.

Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 38, pl. VI, figs. 1-4.

Actinostome moderately large; primary spines often with 'wings' or 'buttresses'; ambulacral plates crowded with tubercles; no tridentate pedicellariae.

1 specimen from *Ingolf* St. 9, west of Iceland, 300 fms.

This is one of the type specimens.

4. *Stereocidaris indica*.

Döderlein, 1901. Zool. Anz., 23, p. 19; 1906, *Valdivia* Ech., pl. X, figs. 1 and 2, pl. XI.

Very close to *S. capensis*, but supposed to have more slender spines and different perforated plates in the pedicels.

6 specimens from the Indian Ocean, Saya de Malha, 150 fms. (*Gardiner*).

These specimens are apparently specifically identical with

that from Natal, listed above as *S. capensis*, confirming my opinion that *S. indica* and *S. capensis* can scarcely be maintained as separate forms. Except for the fact that most of the primary spines are broken, these are very fine examples, and show no diversity in form or colour. The primaries are slender, cylindrical, without ridges, white with purplish-grey collar. The test with its small spines is yellow-greenish on the abactinal system, but becomes greyish in the mid-zone and then greyish-white; the secondary spines are grey, dark at the tips. The specimens are 30–45 mm. in diameter.

5. *Stereocidaris japonica*.

Dorocidaris japonica Döderlein, 1885. Arch. f. Naturg., 51 (1), p. 76.

Stereocidaris japonica Döderlein, 1887. Jap. Seeigel, p. 34, pl. III.

Test somewhat conical but low, with few primary spines above the ambitus, but whole abactinal surface densely covered with miliary tubercles.

1 specimen from Japan, Misaki.

This is a superb specimen, 40 mm. in diameter, and shows well the striking characteristics of the species.

9. AUSTROCIDARIS.

H. L. Clark, 1907. Bull. M.C.Z., 51, p. 212.

Type, *Temnocidaris canaliculata* A. Agassiz, 1863. Bull. M.C.Z., 1, p. 18.

Test somewhat flattened; abactinal system with relatively few spines; all coronal plates carry primaries; genital pores large.

1. *Austrocidaris canaliculata*.

Temnocidaris canaliculata A. Agassiz, 1863. Bull. M.C.Z., 1, p. 18.

Austrocidaris canaliculata H. L. Clark, 1907. Bull. M.C.Z., 51, p. 212. A. Agassiz, 1881. *Challenger* Ech., pl. 11, figs. 1–3 (as *Goniocidaris canaliculata*). Mortensen, 1910. Swedish South Polar Exp. Ech., pl. IV, figs. 4–11.

Actinal primaries not peculiar; median ambulacral and interambulacral areas bare and more or less conspicuously sunken; abactinal system rather small, but ocular plates usually all insert.

34 specimens, of which 5 are bare and 2 are without locality labels. Localities represented are: Antarctic Seas; Straits of Magellan (*Challenger*); St. 313, east entrance to Straits of Magellan, 55 fms., sand (*Challenger*); Falkland Islands; Falkland Islands, Port William; Falkland Islands, Stanley; St. 315, Falkland Islands, 5–12 fms., sand and gravel (*Challenger*); St. 320, off the mouth of the River Plate, 600 fms. (*Challenger*). 4 specimens from the Falkland Islands and 2 from *Challenger* St. 320 were labelled *Dorocidaris papillata*.

The seven specimens from *Challenger* St. 315 are particularly fine; they had been examined by Mortensen and one had been separated from the others as possibly different, but careful examination failed to reveal any distinctive peculiarities. The two specimens from St. 320 are notable for the depth at which they were taken; one is very young, but the other is 31 mm. in diameter, and has spines 67 mm. long. This one is evidently the type of *Stereocidaris lorioli* Mortensen. I examined it with great care and am fully satisfied that it is *A. canaliculata*. The extra long spines and the slight peculiarities in the pedicellariae are probably associated with the depth at which it lived.

2. *Austrocidaris gigantea* sp. nov. PLATE III, figs. 1 and 2.

Test only slightly flattened, 53 mm. in diameter and 32 mm. high. Abactinal system 24 mm. across, with all the oculars more or less broadly insert, well covered with small spines. Actinostome somewhat smaller. Interambulacra about 28 mm. wide in midzone, with the ambulacra less than 6; both are fully tuberculated, with no bare median area or line. Coronal plates only 6 or 7 to a column; ambulacral plates about 10 to each coronal plate in midzone. Pore-pairs normal, but very close together. Primary araeolae on the coronal plates very large, more or less merging on upper and lower sides, excepting only the uppermost. Primary spines 80 mm. long but only 2 mm. in diameter, white, perfectly smooth but not shining, tapering to a blunt yellow or brownish point. Muscles at their base enormous and very conspicuous, light brown. Oral primaries slender, flat, 15-20 mm. long and 2 mm. wide, not greatly flattened but with a blunt, flat tip and smooth, entire margins. Pedicellariae numerous, all of the 'small globiferous' type, variable in size, the largest with valves about a millimeter long. The shape and general appearance of the valves is very much like those of the so-called large globiferous pedicellariae of *Austrocidaris nutrix* as figured by Mortensen (1903, *Ingolf* Ech., pt. 1, pl. X, fig. 4). Colour of test and small spines yellow-brown.

South Victoria Land, off Coulman Island, 100 fms. *Discovery* coll. 2 specimens.

The two individuals are of the same size and appearance. At first glance they remind one of *Eurocidaris geliberti* Koehler, but the abactinal system and the oral spines are too different to permit any confusion with that species. The huge swollen muscles of the primary spines may owe their striking appearance to some treatment received by the specimens when collected or preserved, but the indications are that these muscles are exceptionally well developed.

3. *Austrocidaris nutrix*.

Cidaris nutrix Wyville Thomson, 1876. Jour. Linn. Soc., **13**, p. 62.
Austrocidaris nutrix H. L. Clark, 1907. Bull. M.C.Z., **51**,
 p. 213. Mortensen, 1909. Deutsch. Südpolar-Exp. Ech.,
 pl. IV, figs. 5 and 6, pl. VI, figs. 2, 4-9, 11 and 12 (as *Euro-*
cidaris nutrix).

Test flattened; primary spines not flat; secondary spines club-shaped; abactinal system large, but ocular plates usually exsert.

28 specimens from the following localities: *Challenger* St. 147, west of the Crozet Islands, 1,600 fms., globigerina ooze; Kerguelen Island, 25 fms.; Kerguelen, Royal Sound; Kerguelen, Christmas Harbour; Kerguelen, Balfour Bay; Kerguelen, Betsy Cove; *Challenger* St. 150, west of Heard Island, 150 fms., rock; *Challenger* St. 151, off Heard Island, 75 fms., mud; *Challenger* St. 156, Antarctic Ocean, 1,975 fms., diatom ooze. Nearly all these specimens were labelled *A. canaliculata*.

The specimens from Stations 147 and 156 are much too young to identify properly. The 9 specimens from St. 150 and 2 from Christmas Harbour, 120 fms., have very long spines; one specimen 14 mm. in diameter has primaries 37 mm. long. These remind one of the long-spined variety of *A. canaliculata* taken at *Challenger* St. 320. The specimen from Balfour Bay is very fine and still carries young on the peristome.

4. *Austrocidaris platyacantha* sp. nov. PLATE II, fig. 1.

Test somewhat flattened, 43 mm. in diameter and 23 mm. high. Abactinal system 24 mm. across, with oculars III and IV insert but I, II and V slightly exsert. In another smaller specimen all the oculars are fully insert, and it is probable that this is the usual condition. Actinostome about 20 mm. across. Coronal plates 7 or 8 in each column; at ambitus there are about 5 ambulacral plates to each interambulacral. Ambulacra not quite 5 mm. wide, fully covered with tubercles, each plate having 2 or 3 tubercles. Interambulacra about 21 mm. wide, each plate with numerous close-set miliary tubercles; but there is a distinct bare line over 1 mm. wide in the median area. Ambulacral pores close together, but not at all in contact or united in any way, nor is either one divided or even apparently so; they are thus quite as usual in the genus. Genital pores large and conspicuous. Primary spines mostly broken or fallen off, notable for the excessive flattening, and in many cases widening at the tip; the longest is 70 mm., with the flat tip 6 mm. wide; another is 10 mm. wide at the tip. In one of the paratypes, many of the primaries have 2-5 conspicuous teeth or thorns, on each side, close to the base. Secondary spines club-shaped with very thick tips. Actinal primaries somewhat dagger-shaped, but not conspicuously so.

Pedicecellariae fairly common, but all of one kind—globiferous, without end tooth, much like those of *A. nutrix*.

Colour of test and small spines more or less dark brown; primaries purple at base, paler distally, nearly white at tip.

5 specimens from Antarctic Seas, 4 from South of Balleny Island (*Terra Nova*), and 1 from Coulman Island, 100 fms. (*Discovery*). Of the *Terra Nova* specimens one was labelled '*Notocidaritis mortenseni*' and three '? *Ctenocidaritis perrieri*'. The *Discovery* specimen is one of the group of Cidarids which Bell named '*Cidaritis canaliculata*'.

For the holotype of this fine species I have selected one of the *Terra Nova* specimens, and this is the one figured (Pl. II, fig. 1). It is only 27 mm. in diameter by 16 mm. high, but it has more of the remarkable primaries still attached to the test than any of the other specimens; the best of these primaries is 65 mm. long by 12 mm. across the tip. The largest specimen is the one selected for description. The smallest is only 17 mm. by 9, with its largest primary spine 35 by 5.5 mm. The *Discovery* specimen is 23 mm. by 12; its largest primaries are 45 mm. long, 5-6 mm. wide and only 1 mm. thick at tip.

The extraordinary spines remind one at once of *Cidaritis blakei*, but they are not so fan-shaped as in that species. Not all the primaries are widened to the extreme, but all the fully developed upper ones are at least flattened and 2 or 3 mm. wide near the tip.

10. CENTROCIDARIS.

A. Agassiz, 1904. Mem. M.C.Z., 31, p. 32.

Type, *Goniocidaritis doederleini* A. Agassiz, 1898. Bull. M.C.Z., 32, p. 73.

Test very flat; ambulacra very wide, 0.50-0.55 of interambulacra.

1. *Centrocidaris doederleini*.

Goniocidaritis doederleini A. Agassiz, 1898. Bull. M.C.Z., 32, p. 73.

Centrocidaris doederleini A. Agassiz, 1904. Mem. M.C.Z., 31, p. 33, pl. XIV, figs. 1 and 2.

1 specimen from *Albatross* St. 4,642, Galapagos Islands, off Hood Island, 300 fms.

This is a small but typical example collected by the *Albatross* in 1904 on a bottom of broken shells and globigerina ooze.

11. GONIOCIDARIS.

Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 337.

Type, *Cidarites geranioides* Lamarek, 1816. Anim. s. Vert., 3, p. 56.

Ambulacra wide; median interambulacral areas more or less bare and sunken, especially at angles of coronal; size relatively large; test and spines coarse and stout.

1. *Goniocidaritis geranioides*.

Cidarites geranioides Lamarek, 1816. Anim. s. Vert., 3, p. 56.
Goniocidaritis geranioides Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 337. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. 1 g. figs. 3 and 4.

Tubercles numerous; bare areas confined to horizontal sutures, near inner end; abactinal system almost uniformly covered with tubercles.

27 specimens, of which 3 are without locality labels. The following localities are represented: 'South Seas'; Van Diemen's Land; Tasmania; *Challenger* St. 162, Bass Straits, off East Moncœur Island, 38-40 fms. Many of these specimens were labelled *G. tubaria*, and several were labelled *G. quoyi*.

A careful comparison of typical specimens of *G. tubaria* and *G. geranioides* as defined in my paper on the Cidaridae (1907, Bull. M.C.Z., 56, p. 197), led me to consider them as distinct species, but now, after examining nearly five hundred specimens of the two forms, I find that they intergrade completely, particularly in Bass Straits. Of the 20 specimens taken by the *Challenger* at her St. 162, 13 are referable to *G. tubaria* and 7 to *G. geranioides*. The latter form seems to be characteristic of Tasmanian waters, but I have not seen specimens from New South Wales or from West Australia, where typical *G. tubaria* is very common.

It is certain beyond question that no type of primary spine is correlated with the test characters of either form. Both are extremely variable and either may have long, slender, only slightly thorny spines, or short, stout, extremely thorny spines, or any intermediate stage. So far I have not been able to correlate the spine characters with any factor such as age, locality, depth of water or character of bottom.

The largest specimen of typical *G. geranioides* in the British Museum is 47 mm. in diameter and has 11 coronal plates in a column.

1 a. *G. geranioides* var. *tubaria*.

Cidarites tubaria Lamarek, 1816. Anim. s. Vert., 3, p. 57.
Goniocidaritis tubaria Lütken, 1864. Bidr. Kunds. Ech., p. 137.
 H. L. Clark, 1907. Bull. M.C.Z., 51, pl. X, fig. 5 and pl. XI.

Tuberculation much less general than in typical *G. geranioides*; median areas conspicuously sunken and bare.

82 specimens, of which 17 are without locality labels. The localities represented are: New South Wales, Port Jackson; Bass Straits; Tasmania; *Challenger* St. 161, Victoria, entrance to Port Phillip, 38 fms.; *Challenger* St. 162, Bass Straits, off East Moncœur Island, 38-40 fms.; Victoria, Port Phillip; Victoria, Port Phillip Heads; South Australia; South Australia, Port Adelaide; West Australia, King George's Sound; West Australia, Freemantle; North-west Australia.

There are also 2 specimens labelled 'Mauritius', an obvious error. Several of the above specimens were labelled *Goniocidaris quoyi*, 2 were labelled *G. canaliferus*, and many were labelled *G. geranioides*.

This excellent series reveals the great diversity shown by this common Australian sea-urchin, especially in the primary spines. The largest specimens are 55 mm. in diameter, and may have as many as 13 coronal plates in a column; the abactinal system is only 20 mm. across, and the actinostome is even smaller. Three specimens from an unknown locality have the tests 35–40 mm. in diameter and remarkably flattened; the upper primary spines are only 15–20 mm. long, with tips 6–8 mm. across. Another remarkable specimen from an unknown locality has genitals 2 and 3 fused together to form the madreporite, thus excluding ocular III from the periproct, although the other four oculars are fully insert.

2. *Goniocidaris umbraculum*.

Hutton, 1878. Trans. N.Z. Inst., **11**, p. 306. H. L. Clark, 1907. Bull. M.C.Z., **51**, pl. X, figs. 3 and 4. Mortensen, 1922. Vid. Medd., **73**, pl. VI, figs. 1 and 2.

Similar to *G. tubaria*, but smaller; abactinal system smaller than actinostome; coronal plates with tubercles rather large and of nearly uniform size.

1 specimen from New Zealand, Stewart Island.

This is a very fine specimen, 22 mm. in diameter, showing well the distinctive characters of the New Zealand representative of *G. geranioides*.

12. DISCOCIDARIS.

Döderlein, 1885. Arch. f. Naturg., **51** (1), p. 80.

Type, *Discocidaris (Cidaris) mikado* Döderlein, 1885. Arch. f. Naturg., **51** (1), p. 80.

Size small; test and spines rather delicate; median ambulacral and interambulacral areas usually not bare and sunken.

1. *Discocidaris biserialis*.

Stephanocidaris biserialis Döderlein, 1885. Arch. f. Naturg., **51** (1), p. 79. 1887, Jap. Seeigel, pl. V (as *Goniocidaris biserialis*).

Test low: primary spines with relatively few, long and stout thorns, but otherwise smooth.

9 specimens from Japan, of which 4 are from Misaki (*Insole*), and 2 from the Sagami Sea, 35° 7' N., 139° 44' E., 2 fms. (*Owston*).

This is a very satisfactory series of this well-marked species. Small specimens of *D. biserialis* might be confused with *D. clypeata*, but the more or less olive-green coloration and

the interambulacral secondaries being darkest at the base, are very characteristic features. Of course, the primary spines are a distinctive feature of normal adults.

2. *Discocidaris clypeata*.

Goniocidaris clypeata Döderlein, 1885. Arch. f. Naturg., 51 (1), p. 82. 1887, Jap. Seeigel, pl. VI.

Discocidaris clypeata Mortensen, 1903. Ingolf Ech., pt. 1, p. 29.

Small; coronal plates 6-8, each with but few tubercles; median areas more or less bare; primary spines quite hirsute, at least near base, where there is usually an expanded 'guard'.

4 specimens from Japan, Misaki (*Insole*).

These pretty little Echinoids are 12-16 mm. in diameter, with some diversity in height; the highest is 15 x 11 mm. There is a tinge of red on the primary spines in 2 of the specimens. All have very slender primaries, quite hirsute at least near base, and with an expanded 'guard' there as in *D. mikado*. None of the specimens has the expanded clypeate tips to the abactinal primaries, the feature from which the species derived its name. The bare ambulacral and interambulacral median areas are well marked. Globiferous pedicellariae are usually conspicuous. Secondary spines not numerous, but well developed and with wide tips.

3. *Discocidaris florigera*.

Goniocidaris florigera A. Agassiz, 1881. Challenger Ech., p. 46, pl. I, figs. 7-20.

Primary spines very diverse; colour very light, abactinal system usually tinged with green; secondary spines slender, not peculiar.

4 specimens, 2 from *Challenger* St. 192, near the Kei Islands, 129 fms., mud; and 2 from *Challenger* St. 204, Philippine Islands, east of Mindoro, 100-115 fms., mud.

The examination of this material was of particular interest to me because Mortensen (1903, *Ingolf* Ech.) selected one of the specimens from St. 192 as the type of a new species, and even a new genus, which he named *Schizocidaris assimilis*; he also considers the specimens from St. 204, figured in '*Challenger* Echini', pl. I, fig. 7, as representing a new species, which he terms *Discocidaris serrata*. The single specimen from St. 192 which is thus left to be the type of *D. florigera* is a beauty, 24 mm. in diameter, 17 mm. high, with 6 or 7 coronal plates in each column; the primary spines are extraordinary; one of those on the uppermost plate is only 15 mm. long but is 12 mm. across the expanded top, and one of those on the next plate below is 57 mm. long and not at all expanded. The periproct, genital plates and ambulacra, abactinally, are distinctly greenish, and the primary spines are pinkish

or white spotted with pink. The test and small spines are nearly white. This is probably the specimen represented on pl. 1, fig. 12, of the *Challenger* Report.

The 2 types of Mortensen's *D. serrata* differ from typical *D. florigera* in the absence of expanded spines, but the abactinal system is greenish, and the secondary spines are as in *D. florigera*. The two specimens differ from each other in the degree to which the median ambulacral area is widened and bare: one shows little trace of a midambulacral bare line, but the other is more like *D. assimilis* in this respect. I feel satisfied that these specimens should be referred to *D. florigera*.

The specimen called *S. assimilis* by Mortensen has the greenish abactinal system of *D. florigera*, but the median line of each ambulacrum is barer than in the type of that species. The difference, however, is very slight, and I think there is no doubt that this sea-urchin should be referred to *D. florigera*.

I made no re-examination of the pedicellariae, but I may call attention to the facts that true globiferous pedicellariae were found only on the type of *D. florigera*, and that there is no essential difference in the pedicellariae supposed to be characteristic of *Schizocidaris* and the small globiferous pedicellariae of *D. florigera*. It must be borne in mind that Mortensen's fig. 25, pl. X. is much more highly magnified than fig. 29.

I cannot find any differences between *D. florigera* and *D. clypeata* which can be relied on to distinguish them from each other. The coloration and the rather sparsely, but very coarsely, thorny spines of *D. biserialis* serve to distinguish all specimens of that species, except very young ones, and the spherical or ellipsoidal miliary spines abundant on the median ambulacral and interambulacral areas of *D. mikado* are an excellent and very constant character by which that species may be recognized, even when quite small. But when one attempts to distinguish *D. clypeata* from *D. florigera* the difficulties multiply. As a rule, the primaries in *D. clypeata* are more or less hirsute, at least near the base, and when fully developed have a conspicuous, more or less circular, plate or 'guard' at the base, as often in *D. mikado*; indeed, the primary spines of *D. clypeata* are essentially like those of *D. mikado*. In *D. florigera* the primaries are usually not hirsute and the guard is lacking, but unfortunately this is by no means always true, and some spines may be found that cannot fairly be distinguished from those of *D. clypeata*. I am of the opinion that the two forms are identical, but until I have seen more East Indian material of *Discocidaris* I shall not unite them.

4. *Discocidaris mikado*.

Discocidaris (Cidaris) mikado Döderlein, 1885. Arch. f. Naturg., 51 (1), p. 80. 1887, Jap. Seeigel, pl. VII.

Colour white or very light; primary spines diverse; secondaries very small, spherical or ellipsoidal.

10 specimens from Japan, Misaki (*Insole*).

This is a most interesting series, the smallest 12 mm. in diameter and 7 mm. high, the largest, 22×17 mm. Only 3 specimens (2 small and 1 large) show the dorsal clypeate spines, but the primaries are in general much as in *D. clypeata*. In 3 small specimens the primaries are distinctly reddish.

13. CTENOCIDARIS.

Mortensen, 1910. Swedish South Polar Exp. Ech., p. 3.

Type, *Ctenocidaris speciosa* Mortensen, 1910. Swedish South Polar Exp. Ech., p. 4.

Ambulacral pores small, close together, often more or less yoked by a notch or pit; oral spines very coarsely and conspicuously serrate.

1. *Ctenocidaris perrieri*.

Koehler, 1912. Deux. Exp. Ant. Franc. Echinodermes, p. 150, pl. XII, figs. 4-8.

Genital plates little if any wider than long; primary spines long and very thorny.

7 specimens from Antarctic Seas, South Victoria Land and eastward. Localities represented are: Ross Sea, 158 fms. (*Terra Nova*); East end of Barrier, 100 fms. (*Discovery*); Winter Quarters, 100 fms. (*Discovery*). Of the *Terra Nova* specimens, 1 was labelled simply '*Cidaris*'; the other 2 were named *Notocidaris mortenseni*. The *Discovery* specimens were labelled *Cidaris canaliculata*.

There is enough difference between the larger and smaller specimens of this series to make one hesitate about naming them all *C. perrieri*, but I believe that the differences are due to age. The *Terra Nova* specimens are very fine; the largest is 55 mm. in diameter, 33 mm. high, and has primary spines 100 mm. long but only 3.5 mm. in diameter. The *Discovery* specimens are much smaller and 2 at least appear to be young. The primary spines are very slender and are more or less purplish basally, especially on the neck; these, I think, may be youthful traits.

Although the localities where *C. perrieri* was originally taken lie nearly 120° to the east, I cannot find any satisfactory reasons for not calling the present series by that name. Of course it is possible that actual comparison of specimens might lead to a different conclusion.

2. *Ctenocidaris speciosa*.

Mortensen, 1910. Swedish South Polar Exp. Ech., p. 4, pl. III, figs. 1 and 2, pl. IV, figs. 1-3.

Genital plates much wider than long; primary spines of moderate length and nearly smooth.

18 specimens from the following localities: South Georgia, off Larsen Point, 50 fms.; South Victoria Land, off Coulman Island, 100 fms.; south of Balleny Islands, 200 fms. The specimens from off Coulman Island are labelled *Goniocidaris canaliculata*, while those from south of Balleny Islands are named *Notocidaris mortenseni*.

All these specimens are young, the largest only 30 mm. in diameter. Much of Mortensen's original material came from South Georgia, and the present specimens from there answer well to his description. The specimens from the South Victoria Land region show some differences, but I find none which would warrant separating them in any way.

14. APOROCIDARIS.

A. Agassiz and H. L. Clark, 1907. Mem. M.C.Z., 34, p. 36.

Type, *Porocidaris milleri* A. Agassiz, 1898. Bull. M.C.Z., 32, p. 74.

Abactinal system very large, 0.60-0.70 of test diameter; ambulacral plates few, seldom more than 30 in a column.

1. *Aporocidaris antarctica*.

Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., p. 25, pl. III, figs. 5 and 7, pl. V, figs. 9-11.

Test very flat; primary spines long and smooth.

2 specimens from *Challenger* St. 156, 62° 26' S., 95° 44' E., 1,975 fms., diatom ooze. Labelled *Goniocidaris canaliculata*.

Mortensen (1903, *Ingolf* Ech., pt. 1, p. 27) has already recorded his opinion that the specimens from *Challenger* St. 156, listed by Agassiz as *Goniocidaris canaliculata*, are not that species, but are related to Koehler's *Porocidaris incerta*. In this I think he is correct, and I consider that, in spite of their rather poor condition, they agree well with his description of *A. antarctica*, a species described in great detail from the same region as the *Challenger* specimens. These are 13 and 15 mm. in diameter.

2. *Aporocidaris milleri*.

Porocidaris milleri A. Agassiz, 1898. Bull. M.C.Z., 32, p. 74. 1904, Mem. M.C.Z., 31, pl. VI.

Aporocidaris milleri A. Agassiz and Clark, 1907. Mem. M.C.Z., 34, p. 37.

Test moderately flattened: primary spines long and slender, but quite rough.

1 specimen from *Albatross* St. 4,647, $4^{\circ} 31' S.$, $87^{\circ} 42' 30'' W.$, 2,005 fms., very light grey globigerina ooze.

This is a good and typical example of the species.

15. ACANTHOCIDARIS.

Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 21.

Type, *Cidaris curvatispinis* Bell, 1893. Trans. Zool. Soc. London, **13**, p. 303.

Primary spines long and smooth, tapering, often distinctly curved; collar about one-fifth of length of spine.

1. *Acanthocidaris curvatispinis*.

Cidaris curvatispinis Bell, 1893. Trans. Zool. Soc. London, **13**, p. 303, pl. XXXVIII.

Acanthocidaris curvatispinis Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 29.

Primaries reddish or brownish, with collar light and unspotted; secondaries cream-colour or yellowish.

1 specimen from Mauritius.

This is the holotype of this very remarkable species, and is, I believe, still unique. It was not considered advisable to partially clean the test for examination, as there is no question as to the status of either genus or species.

16. HISTOCIDARIS.

Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 22.

Type, *Porocidaris elegans* A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 198.

No globiferous pedicellariae of any kind; primary spines long, straight, usually cylindrical, white, often shining; collar coloured.

1. *Histocidaris elegans*.

Porocidaris elegans A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 198. 1881, *Challenger* Ech., pl. III.

Histocidaris elegans Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 30.

Abactinal system about half of test diameter; pedicellariae with 3 valves; primaries rather slender; collar of primaries light brown.

8 specimens from off Sydney, N.S.W., 3 of which are from *Challenger* St. 164 B, 410 fms.

This species is now the best-known member of the genus, ranging from the Philippines to Bass Straits and westward to the African coast. Specific limits in the genus are as yet very indefinite and much more material is needed. The present

series of 8 specimens is too homogeneous a lot to throw any new light on the subject.

2. *Histocidaris purpurata*.

Porocidaris purpurata Wyville Thomson, 1872. Ann. Mag. Nat.

Hist. (4), 10, p. 302. 1874, Phil. Trans. R. S., 164 (2), pl. LIX.

Histocidaris purpurata H. L. Clark, 1916. *Endeavour* Ech., p. 106.

Pediculariae with only 2 valves : primaries relatively stout, often swollen near base.

4 specimens, 2 without exact locality (*Porcupine*) and 2 from off south-western Ireland, 610-680 fms., and 666-778 fms. (*Irish Fishery Board*).

The specimens from off south-western Ireland are very fine examples, and the two without locality are undoubtedly Wyville Thomson's types. In his original paper (1872) Thomson says they (4 specimens) were taken in '500-600 fms. off the Butt of the Lews', while in his final report he gives the locality as 'about 100 miles to the north of the Hebrides'. Of the 4 specimens only 2 are now in the British Museum, a bare test and a fine individual with spines; the latter is the type of Mortensen's variety *talismani*, which it is now agreed is not valid.

Order 2. DIADEMATOIDA, Duncan.

Test regular; periproct abactinal, opposite mouth; 2 columns of plates (usually compound) in each ambulacrum and 2 in each interambulacrum; peristomal gills and sphaeridia present.

Suborder 1. AULODONTA, Jackson.

Teeth grooved; primary tubercles perforate; epiphyses of lantern narrow.

Family 1. ASPIDODIAEMATIDAE, Duncan.

Ambulacral plates simple; coronal plates thin; oculars large and all insert; periproct leathery, only partially plated.

This little family is represented in the Museum by 16 specimens, mostly small. Although adults are generally easy to recognize, young ones present much difficulty, so that it has not been possible to identify satisfactorily all of the 16 in this series.

1. ASPIDODIAEMA.

A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 199.

Type, *Aspidodiadema tonsum* A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 199.

Distinct primary tubercles present in actinal part of ambulacra.

1. *Aspidodiadema nicobaricum*.

Döderlein, 1901. Zool. Anz., **24**, p. 21. 1906, *Valdivia* Ech., pl. XX, figs. 1-1 b.

Ambulacra broad; few miliaries on buccal plates; test more or less purple actinally; primary spines purplish.

2 specimens from *Challenger* St. 170, off Kermadec Islands, 630 fms., rocks. These were labelled *Aspidodiadema tonsum*.

These specimens are young, and the characteristic violet colour is evident only on the peristome; but the rather broad ambulacra, and especially the fewness of the tubercles (and spines) on the buccal plates, satisfy me that they should be referred to this species.

2. *Aspidodiadema tonsum*.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 199. 1881, *Challenger* Ech., pl. VIII, figs. 1-9.

Ambulacra narrow; miliary tubercles on buccal plates numerous; anal plates densely covered with spines; primary spines purplish.

3 specimens, 1 without locality, 1 from the Philippine Islands, off Cebu, 100 fms. (*Challenger*), and 1 said to be from Brazil, off Macio, 1,700 fms. (*Challenger*).

The specimen from off Cebu is a good example of the species. The one said to be from Macio is very similar, and I feel sure that it did not come from the Atlantic Ocean.

2. PLESIODIADEMA.

Pomel, 1883. Class. Meth. Ech., p. 106.

Type, *Aspidodiadema microtuberculatum* A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 199.

No primary tubercles present in ambulacra anywhere.

1. *Plesiodiadema antillarum*.

Aspidodiadema antillarum A. Agassiz, 1880. Bull. M.C.Z., **8**, p. 73. 1883, Mem. M.C.Z., **10**, No. 1, pl. IX.

Anal system with numerous small plates; ambulacra not very wide; size small; ambulacral plates with 1-3 tubercles on each, 1 tubercle on every second or third plate larger than the others.

8 specimens from the following localities: St. 29, Gulf of Mexico, 955 fms. (*Blake*); Brazil, off Macio, 1,700 fms. (*Challenger*); St. 122, off eastern Brazil, 356 fms. (*Challenger*). The specimens from Brazil were all labelled *Aspidodiadema microtuberculatum*.

The specimen from *Challenger* St. 122 is very young, and hence its identity is by no means certain. Those from off Macio, one of which is bare, are 10–13 mm. in diameter; the two *Blake* specimens are young and their specific characters are not yet very well marked.

2. *Plesiadiadema globulosum*.

Dermatodiadema globulosum A. Agassiz, 1898. Bull. M.C.Z., **32**, p. 76. 1904, Mem. M.C.Z., **31**, pl. XXIV, figs. 1–3.

Coronal plates few; anal system with 5–8 larger plates at centre; test high; ambulacra broad; valves of pedicellariae long and slender.

1 specimen from the coast of Chile (*Challenger*), labelled *Aspidodiadema microtuberculatum*.

This specimen lacks primaries; it is 26 mm. in diameter by 19 mm. high, and is evidently a *P. globulosum*.

3. *Plesiadiadema microtuberculatum*.

Aspidodiadema microtuberculatum A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 199. 1881, *Challenger* Ech., pl. VIII, figs. 10–16.

Plesiadiadema microtuberculatum Pomel, 1883. Class. Meth. Ech., p. 106.

Coronal plates few; anal system with numerous small plates; ambulacral plates numerous; buccal plates with spines.

2 specimens from *Challenger* St. 134, north-west of Tristan da Cunha, 2,025 fms., globigerina ooze.

One of these specimens, 11 mm. in diameter, is in good condition. It is not very typical of the species, for the anal plates are few and in a single ring, as in *P. globulosum*, and there are only 3 or 4 ambulacral plates to each interambulacral at the ambitus. The identification is thus not beyond question.

Family 2. DIADEMATIDAE, Peters.

Ambulacral plates compound; coronal plates usually more or less imbricate; base of corona resorbed; peristome not plated.

The series of specimens belonging to this family is not extensive, rather more than 200, but of the 18 species, 2 are here described for the first time, and several others are rare and incompletely known. The genus *Coenopedina* is included in this family, as no characters have been found that warrant its being placed elsewhere. Its close relationship to *Centrostephanus* I have discussed previously (1912, Mem. M.C.Z., **34**, p. 213), and examination of further material has convinced me that these two genera should be placed in the Diadematidae. The solidity of the spines in *Coenopedina* distinguishes it

easily from *Centrostephanus*, but both *Astropyga* and *Chaetodiadema*, well-known genera of Diadematidae, have spines which are virtually solid. The family Pedinidae may be retained for certain extinct genera, but I am not prepared to offer any suggestions as to its limits.

The question of the proper name to use for the present family is a difficult one. By all recognized codes of nomenclature the name *Diadema* cannot be used for sea-urchins, and *Centrechinus* (Jackson) is the proper name for the genus so-called. The names *Centrechinus* and Centrechinidae should therefore be used instead of *Diadema* and Diadematidae. But *Diadema* has been used for a century without any interruption (till 1912) or confusion, for the tropical sea-urchins with long, black, hollow, poisonous spines, and although it has also been used in other groups, this use has been intermittent and relatively unimportant. Moreover, *Diadema* has become the root for a large number of generic names among Echinoidea, and has more or less important significance in showing relationship. For these reasons such authorities as Mortensen and Bather are strongly opposed to abandoning the name, and propose to continue its use and to secure it a place on the list of *Nomina Conservanda* authorized by the International Congress of Zoologists. Under the circumstances, in deference to their judgement, I have decided to use the old name in the present Catalogue.

The family is not a large one, and the 10 genera of recent species which it includes are easily recognized. All are essentially warm-water forms, and the family as a whole is very characteristic of tropical coral reefs. None of the genera is confined to deep or even moderately deep water, and few of the species occur in water deeper than 200 fms. Nearly all the well-known species grow to a large size, 75–125 mm. in diameter or more, but most of the species known from only a few specimens are much smaller. *Leptodiadema* is based on a specimen only 9 mm. in diameter and *Lissodiadema* on 2 specimens of 10 and 22 mm. respectively. It is very probable that adult specimens of these genera, and of the species known only from individuals of similar size, will prove to be very much larger.

1. DIADEMA.

Gray, 1825. Ann. Phil., 10, p. 426.

Type, *Echinometra setosa* Leske, 1778. Add. ad Klein, p. 36.

Interambulacral primary spines rough, hollow; test moderately high, its vertical diameter 0.40 of horizontal or more; buccal plates without spines; ambulacra narrower

abactinally than at ambitus, with few or no secondary tubercles above midzone.

1. *Diadema antillarum*.

Cidaris (Diadema) antillarum Philippi, 1845. Arch. f. Naturg., 11 (1), p. 355.

Diadema antillarum A. Agassiz, 1863. Bull. M.C.Z., 1, p. 19. Nutting, 1895, Bull. Univ. Iowa, Lab. Nat. Hist. (3), p. 224, unnumbered plate, fig. 1 (young *Diadema*, labelled *Aspidodiadema* sp.).

Second series of primary tubercles begins on coronal plates 4, 5 or 6; abactinal system less than half diameter of peristome; gill cuts deep and narrow; small tubercles rather few.

10 specimens from the Danish West Indies, St. Thomas; St. Croix; Fernando Noronha; Ascension; Canary Islands; Cape Verde Islands; and St. Helena.

It would seem natural to refer the specimens from Ascension to Mortensen's *D. ascensionis* (1909, Deutsch. Südpolar-Exp. Ech., p. 55), but I am unable to find any good ground for recognizing more than one species in the tropical Atlantic. Indeed, without knowing the origin of the specimens, one would be hard put to it to distinguish *D. antillarum*, *D. mexicanum* and *D. paucispinum* from each other, with only museum specimens in hand, and particularly if these were only half grown; and Mortensen's types of *D. ascensionis* are scarcely that! All of the British Museum material from Ascension, the Canaries, the Cape Verdes and even from St. Helena appears to be identical with the specimens from St. Thomas, St. Croix and Fernando Noronha. I did not compare critically the tridentate pedicellariae of these specimens, for I should expect them to show considerable diversity; and this I should not consider of sufficient importance to regard as specific or even varietal, though it were as great as that shown in Mortensen's figures (1904, Dansk. Selsk. Skr. (7), 1, No. 1, pl. III, figs. 1, 7 and 20, and 1909, Deutsch. Südpolar-Exp. Ech., pl. XVI, figs. 17 and 22), unless correlated characters of test, spines or coloration could be shown to exist.

2. *Diadema mexicanum*.

A. Agassiz, 1863. Bull. M.C.Z., 1, p. 20. (No satisfactory figure extant.)

Similar to *D. antillarum*, but gill cuts shallow and wide; valves of tridentate pedicellariae compressed at base.

15 specimens from Acapulco, Gulf of California, and 'San Francisco'. The last is doubtless an erroneous label, as the species is not known from north of Mexico.

These specimens throw no light on the validity of the species or its relation to the other members of the genus.

3. *Diadema savignyi*.

Michelin, 1845. Rev. Mag. Zool., p. 15. H. L. Clark, 1921. Carnegie Inst. Mar. Biol. Papers, 10, pl. XVII, figs. 1 and 2 (as *Centrechinus savignyi*).

Abactinal system larger than peristome; no white anywhere, but a red-purple tinge generally more or less evident, especially orally.

11 specimens from Muscat, Mauritius, and Macclesfield Bank, 35–40 fms.

These are all small, but one of the two from Muscat may be adult; the other is a young one with banded spines. The four from Mauritius are notable, for the tests, 25–35 mm. in diameter, are very light coloured (possibly bleached in some way), and the primaries are white with violet-red bands. Although they are very handsome, they are obviously young, and are not typical representatives of this usually black species. However, the blackest adults, when dry, generally show more or less of a violet-red tinge. The specimens from Macclesfield Bank are too young for certain identification.

4. *Diadema setosum*.

Echinometra setosa Leske, 1778. Add. ad Klein, p. 36.

Diadema setosa Gray, 1825. Ann. Phil., 10, p. 4. H. L. Clark, 1921. Carnegie Inst. Mar. Biol. Papers, 10, pl. XVII, figs. 3 and 4 (as *Centrechinus setosus*).

Conspicuous white or light coloured spots present dorsally, 1 in each interambulacrum; more or less white about mouth; second series of primary tubercles begins on seventh or eighth coronal plate.

48 specimens, of which 7 are without locality labels. Localities represented are: 'Mediterranean'; Gulf of Suez; Gulf of Akabah; Gulf of Aden, Berbera; Mauritius; Seychelles; German East Africa, Dar-es-Salaam; Ceylon; Singapore; Billiton; Macclesfield Bank, 36 fms.; Japan, Misaki; Japan, Sagami Bay; Java, Batavia, Edam Island; North-western Australia, Evans Bank, 12–15 fms.; Baudin Island; Queensland, Port Molle; South-west of the Tonga Islands, Minerva Reefs.

The members of this large and heterogeneous series agree in the presence of white (or at least, light) spots in the interambulacra and a light colour (white?) about the mouth; in all other respects there is notable diversity. There are some perplexing specimens; thus, 5 of the specimens from Mauritius show the white interambulacral spots; but the big tridentate pedicellariae have the valves broad as in *D. savignyi*! This is most disconcerting, but I think we must follow the coloration rather than the pedicellariae in distinguishing the species of *Diadema*. Another specimen from Mauritius, 47 mm. in diameter, seems to be an albino, as there is little pigment on

the test and none in the primary spines; enough is present in the interambulacra to make the characteristic white spots evident. In contrast to this specimen is the one from Edam Island, which is very black, and has the ambulacral spots pale reddish rather than white; this may be due to staining after the specimen was collected. An example from Billiton is notable for the *green* colour of the primaries, especially on the ambulacra: this unusual coloration has proved misleading as the specimen is labelled *Echinothrix diadema*! One of the specimens without locality is remarkable for the flatness of the test, 85 mm. in diameter but only 33 mm. high.

I have already had occasion to comment on young *Diademas* from Sagami Bay (1908. Bull. M.C.Z., **51**, p. 302), and this additional material from Japan leaves me as perplexed as ever. The smallest example is a lovely little violet and yellow-green individual such as I described. The others (6) are reddish and reddish-white in colour, with the primary spines banded as usual in young *Diademas*; the tests are 50–60 mm. in diameter, and the second series of interambulacral tubercles begins on the 5th or 6th coronal plate, not on the 7th or 8th, as is usual in this species. One of the specimens shows the interambulacral white spots clearly, but the others indistinctly or not at all; in all, however, the peristome is reddish-white. No perfect tridentate pedicellariae of normal size were found, but one broken one and one very small one had the valves narrow and compressed. I think it probable that the Sagami Bay *Diadema* is an undescribed species, but until adult specimens are procured it would be foolish to try to separate it from *D. setosum*.

In addition to the *Diademas* already listed the Museum possesses 10 very young specimens that I am unable to assign to any particular species. Of these 6 are without locality; the other 4, from Muscat, Christmas Island, Macclesfield Bank, and Rotuma are very probably *D. savignyi*, but they may be *D. setosum*.

2. ECHINOTHRIX.

Peters, 1853. Monatsb. Berlin Akad., p. 484.

Type, *Echinus calamaris* Pallas, 1774. Spic. Zool., **1**, fasc. 10, p. 31.

Primary spines rough, hollow; no spines on buccal plates; ambulacra with numerous secondaries above ambitus and wider abactinally than in midzone.

1. *Echinothrix calamaris*.

Echinus calamaris Pallas, 1774. Spic. Zool., **1**, fasc. 10, p. 31.

Echinothrix calamaris A. Agassiz, 1872. Rev. Ech., pt. 1, p. 119.

Döderlein, 1903. Denkschr. Ges. Jena, **8**, pl. LIX, fig. 9, pl. LXIII, fig. 6.

Interambulacral primary spines fragile, the inner cavity more than half diameter of spine; minute teeth covering spines arranged in distinctly separated whorls; colour usually black and white (larger spines) and yellow-green (ambulacral spines), very handsome; but old individuals may become dull and dark and lose their distinctive appearance.

20 specimens. Localities represented are: Mauritius; Mal-dive Islands, Minokoi (*Gardiner*); Andaman Islands; East Indies; Macclesfield Bank, 31-40 fms.; Rotuma; Fiji Islands, Kandavu; Samoa. The specimens from Minokoi and from Macclesfield Bank are young, and were labelled *Astropyga radiata*; those from the East Indies and the Andaman Islands and 1 from Mauritius were labelled *Diadema setosum*; 3 from Mauritius and 1 without locality were labelled *E. desorii*. A fine specimen from Rotuma was labelled *E. turcarum*.

The labelling of these specimens emphasizes well the diversity of appearance. The big adults from Mauritius are dull and dark-coloured, very different from typical *E. calamaris*, and the specimen from Samoa is as dark as *E. diadema*, but has the spines of *E. calamaris*. The specimen from Kandavu is typical of *E. calamaris* at its best, when it is certainly one of the loveliest of sea-urchins. The example from Macclesfield Bank is only 19 mm. in diameter; it is notable for the conspicuous anal tube, which is white, from the abundance of calcareous plates, but is also spotted with brown; the bare abactinal interambulacral areas are apple-green, and the interambulacral primaries are relatively huge, pale lavender, indistinctly banded with reddish-brown. The coloration of this individual is very unusual.

2. *Echinothrix diadema*.

Echinus diadema Linné, 1758. Syst. Nat., ed. 10, p. 664.

Echinothrix diadema Lovén, 1887. Bih. Svensk. Vet.-Akad. Handl., 13 (4), No. 5, p. 137. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. III a, fig. 3.

Colour mostly black, with ambulacral spines often rusty-red or brown; primary spines rather solid, the internal cavity small.

17 specimens, of which 2 are bare and 2 are without locality label. Localities represented are: Aden; Mauritius; Andaman Islands; Christmas Island (*Andrews*); Ellice Islands, Funafuti; Rotuma; Samoa. The specimen from Aden was labelled *Astropyga radiata*, and the 2 young ones from the Andaman Islands were labelled *Diadema setosum*.

These specimens range from 11 to 110 mm. in diameter, and show great diversity in the colour of the primary spines, which ranges from uniformly black to a distinct banding with greenish and purplish. Young ones in particular show the banding of the primaries very clearly. The relation between

this species and *E. calamaris* is puzzling: although typical examples of the two are very unlike, in every considerable series are some specimens which are hard to place with confidence. I feel very sure that the two species are quite distinct and ordinarily breed true, but I know of no one character by which they can constantly be distinguished. It is possible that hybridization occurs, and that some of the perplexing intermediates are to be explained thereby. In the British Museum series the two young specimens of *Echinothrix* from the Andaman Islands, labelled *Diadema setosum*, here listed as *E. diadema*, are possible hybrids. The colour is that of *E. diadema*, except that the ambulacral spines are uniformly green as in *E. calamaris*. The interambulacral primaries are quill-like as in *E. calamaris*, but they are not banded.

3. ASTROPYGA.

Gray, 1825. Ann. Phil., 10, p. 426.

Type, *Cidaris radiata* Leske, 1778. Add. ad Klein, p. 116.

Primary spines relatively short, rough, practically solid; actinal surface with normal primary tubercles, poriferous areas becoming wider at peristome.

1. *Astropyga pulvinata*.

Cidarites pulvinata Lamarck, 1816. Anim. s. Vert., 3, p. 59.

Astropyga pulvinata Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 345. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. III a, fig. 4.

Columns of primary tubercles on actinal surface parallel with midline of interambulacrum.

2 specimens, bare and without locality label.

These are large and typical examples of this Mexican and Central American, west coast, species. They are 112 and 123 mm. in diameter.

2. *Astropyga radiata*.

Cidaris radiata Leske, 1778. Add. ad Klein, p. 52.

Astropyga radiata Gray, 1825. Ann. Phil., 10, p. 4. Peters, 1855. Abhandl. Akad. Berlin, 1854, fig. 1 (as *A. mossambica*).

Columns of primary tubercles on actinal surface parallel with margin of ambulacrum.

29 specimens, of which 4 are bare. Localities represented are: British East Africa, Wasin Island, 10 fms. (*Crossland*); German East Africa; G.E.A., Dar-es-Salaam; Mozambique; Natal; Mauritius; Seychelle Islands (*Alert*); Seychelles, Praslin (*Gardiner*); Maldive Islands, Mulaku (*Gardiner*); Andaman Islands; Billiton; Hawaiian Islands, off Honolulu, 18 fms. (*Challenger*). A young specimen from Wasin was labelled *Diadema saeculare*, and the *Challenger* specimens from Honolulu were labelled *A. pulvinata*.

When the *Challenger* Echinoidea were studied by Agassiz, the difference between *A. pulvinata* and *A. radiata* was not clear, and he referred the Hawaiian specimens to the Mexican species. Nevertheless, they are evidently not *A. pulvinata*, and in all essentials they agree well with *A. radiata*. Their colour is very striking, reddish-white and red, much lighter and more showy than in specimens from the Indian Ocean. This handsome coloration is apparently characteristic of the Hawaiian form, as it is shown by all of the 16 specimens in the Museum of Comparative Zoölogy known to be from Hawaiian shores. The specimen from the Andaman Islands, only 25 mm. in diameter, has the test of the deep red colour typical of *A. radiata*; but the spines are banded with pale green and pale red, so that the difference between this individual and one of similar size from the Hawaiian Islands is one of degree and not of kind. Specimens from the eastern coast of Africa are usually quite dark, especially when adult, and the banding of the primary spines is evident only basally. The 2 specimens from Wasin are young and very handsome, but they are much darker than those of similar size from Hawaii. The example from Mozambique is 50 mm. in diameter; compared with a Hawaiian specimen of that size it is much duller and more greenish, and has the tube-feet much more pigmented, making the poriferous areas more conspicuous. The specimen from Billiton is very dark, like those from Africa. One of the Mauritius specimens is greenish-yellow with no red; although its condition is very fine, I think the colour must have been affected by preservation. The *Alert* specimen from the Seychelles is the largest of the series and measures 165 mm. in diameter.

4. MICROPYGA.

A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 200.

Type, *Micropyga tuberculata* A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 200.

Primary spines short, rough but hollow; test low, the vertical diameter about one-third horizontal; pores in ambulacra distinctly biserial.

1. *Micropyga nigra* sp. nov. PLATE III, fig. 3. PLATE IV, figs. 1 and 2.

Test 83 mm. in diameter, by 20 mm. (more or less) in height. As the test was apparently more or less flexible in life, the height of preserved specimens depends on the degree to which they have been flattened. Test, especially the ambulacra, very similar to that of *M. tuberculata*, but from above appearing quite different, as there are very few secondary or miliary

tubercles and spines on the abactinal plates, and those present are relatively large. On a coronal plate, near ambitus, in addition to 5 primary tubercles there are about a dozen small tubercles. In *M. tuberculata* there are 30-40 such tubercles, and these are particularly numerous at the outer end of the plate, next to the ambulacrum, where, in *M. nigra*, there are practically none. Pedicellariae and spicules as in *M. tuberculata*.

Colour very dark; the whole abactinal surface, including the spines, is so heavily pigmented as to be almost black. Actinal surface and especially gills nearly, if not quite, as black.

New Britain, 50-70 fms. (Willey). 2 specimens.

These specimens were identified by Bell as *Astropyga elastica* Studer, but Mortensen (1904, Dansk. Selsk. Skr. (7). 1. No. 1. p. 20) has stated definitely that they belong to *Micropyga*, and he suggests that they are probably *M. violacea* de Meijere, a species that is even more heavily tuberculated than *M. tuberculata*.

2. *Micropyga tuberculata*.

A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 200. 1881, *Challenger* Echn., pl. VII.

Colour dull violet; many small tubercles on abactinal plates: only 2 columns of primary tubercles in ambulacra.

12 specimens from the *Challenger* collection, taken at these localities: Philippine Islands, off Cebu, 100 fms.; St. 204, 12° 43' N., 122° 10' E., 100-115 fms., mud; St. 209, 10° 10' N., 123° 55' E., 95-100 fms., mud; St. 219, 1° 50' S., 146° 42' E., 150 fms., mud.

These specimens range in size from 26 to 120 mm. across and are a splendid series. Oddly enough 5 of them, although type material, are labelled *Astropyga radiata*; 4 others are labelled *Phormosoma*. As St. 209 is not listed in the *Challenger* Report as a station where *Micropyga* was taken, it is probable that '209' is a slip of the pen for 219.

In the *Challenger* Report, St. 174 is listed as a locality for this species, but the specimen from that station labelled *Micropyga tuberculata* is almost certainly not a *Micropyga*. It is only 8 mm. in diameter, and seems to be a young Echinothuriid, probably an *Araeosoma*.

There are 4 young *Micropygas* in the collection labelled '*Astropyga* yg.' or *A. radiata*, which may well be listed here, but the species to which they belong is very doubtful. That they are *Micropygas* is shown by the extraordinary tube-feet of the abactinal side. Of these young individuals, 3 from New Britain (2 from Blanche Bay) may be the young of *M. nigra*, but they are so light-coloured that I do not like to

assign them to that species. In two the test is red-violet and the primaries are banded; in the smaller (8 mm. by 3) the primaries are 7-8 mm. long, pale green banded with reddish; in the larger (26 × 11 mm.) the primaries are about 12 mm. long, violet, and seldom showing the bands. The third specimen is 15 mm. in diameter, lacks the violet pigment, and is pale reddish-brown with unbanded greenish spines. It is hard to believe that these three specimens belong to a single species. The fourth young *Micropyga*, 22 mm. across, was taken in the Amirante Islands, 280 fms., by J. Stanley Gardiner. It shows no trace of green but is whitish with violet shades; the primaries tend to violet.

5. CHAETODIADEMA.

Mortensen, 1903. Vid. Medd., p. 1.

Type, *Chaetodiadema granulatum* Mortensen, 1903. Vid. Medd., p. 1.

Primary spines slender, rough, not very long, more or less solid; actinal surface with tubercles becoming small and densely crowded near peristome; poriferous area at peristome reduced to a single series of widely separated pore-pairs.

1. *Chaetodiadema africanum*.

H. L. Clark, 1924. S. Afr. Fish. and Mar. Biol. Surv., Rept. 4, Ech., No. 1, p. 2, pl. 1.

Actinostome small, about three-fourths as large as abactinal system; colours light and dark brown; 4 columns of tubercles at ambitus in each interambulacrum; pore-pairs in an almost unbroken vertical series.

7 specimens from Natal: 2 from off the mouth of Tugela River, 46-55 fms., and 5 from off Cape Natal, 48-54 fms. All were labelled '*Astropyga* yg.'

The two specimens from off the Tugela River are 24 and 34 mm. in diameter. They are nearly white orally, greenish in midzone and pale reddish-brown abactinally; tip of anal tube, a spot on each genital, and lines of bare interambulacral spaces, pink-lavender. Oral spines white, often reddish at tip; other spines pale green; those of midzone may have a broad pale red band occupying half the spine-length.

The 5 specimens from Cape Natal range from 11 to 30 mm. in diameter. The smallest is pale apple-green, darkest abactinally, with a pale pink-lavender spot on each genital. The larger specimens are slightly less green; the spot on the genital is more conspicuous, and a broad line of the same pink-lavender colour extends down each side of bare interambulacral area.

These young urchins are much greener and lighter than

the adults, and the abactinal coloured lines and spots are very much lighter. But these lines and spots are arranged as in *C. africanum* and not at all as in *C. granulatum*, the only other species recorded from the African coast.

2. *Chaetodiadema granulatum*.

Mortensen, 1903. Vid. Medd., p. 1. 1904, Dansk. Selsk. Skr. (7), 1, No. 1, pl. I, figs. 1, 3, 21, and 22.

In each interambulacrum 10–12 columns of primary tubercles; most of actinal surface densely covered with small tubercles and without primaries: blue spots at sides of interambulacra dorsally.

5 specimens, all young, from the following localities: Borneo; Macclesfield Bank, 35–41 fms.; St. 188, Arafura Sea, 28 fms., and St. 190, Arafura Sea, 49 fms., mud (*Challenger*). The *Challenger* specimens were labelled *Astropyga pulvinata*, but have been correctly determined by Mortensen. The specimens from Macclesfield Bank were labelled *Astropyga radiata*.

The smallest specimens, 13 and 19 mm. in diameter, are from Macclesfield Bank: the largest specimen is from St. 188; this is 42 mm. in diameter, or rather less than half grown.

3. *Chaetodiadema japonicum*.

Mortensen, 1904. Dansk. Selsk. Skr. (7), 1, No. 1, p. 28, pl. II, figs. 16 and 19.

In each interambulacrum 6–8 columns of primary tubercles: actinal surface with many primary tubercles: a blue line on each side of interambulacrum dorsally.

2 specimens from Misaki, Japan, labelled *Echinothrix turcarum*.

These are very fine specimens, 70 and 75 mm. in diameter.

6. CENTROSTEPHANUS.

Peters, 1855. Denk. Akad. Berlin f. 1854, p. 109.

Type, *Diadema longispina* Philippi, 1845. Arch. f. Naturg., 11 (1), p. 354.

Primary spines hollow: buccal plates with numerous spines; globiferous pedicellariae present.

1. *Centrostephanus asteriscus*.

A. Agassiz and H. L. Clark, 1907. Bull. M.C.Z., 50, p. 237. 1908, Mem. M.C.Z., 34, pl. LV, figs. 1–6, pl. LVIII, figs. 1–6.

Small; red and white; a white star on abactinal system.

2 specimens from Macclesfield Bank, 35–40 fms., labelled *Diadema saxatile*.

The larger of these is 9 mm. in diameter, about two-thirds as large as the biggest of the original specimens. Both are in

very good condition ; they show no characters by which they may be distinguished from Hawaiian examples. The occurrence on Macclesfield Bank of what was supposed to be an endemic Hawaiian species is worthy of special note.

2. *Centrostephanus longispina*.

Cidaris (*Diadema*) *longispina* Philippi, 1845. Arch. f. Naturg., 11 (1), p. 354.

Centrostephanus longispinus Peters, 1855. Abhandl. Akad. Berlin, 1854, p. 109. G. Chiecchia-Rispoli, 1906. Palaeontogr. Italica, 12, pl. IV, figs. 1-5.

Whitish lines present on abactinal side ; primary spines banded with yellowish-green and purple.

10 specimens, of which 3 are without locality. Localities represented are : France, Nice ; Italy, Naples ; Madeira (?) ; 'Indian Ocean'. The specimens from these last two localities are labelled *Diadema setosum* and *Diadema saxatile* respectively.

It is not unlikely that the 3 small specimens from Madeira (?) came from those islands. Although they are but 4-8 mm. in diameter, with primary spines 10-20 mm. long, they are typical examples of this beautiful sea-urchin. The specimen said to be from the 'Indian Ocean' is 45 mm. in diameter and has spines 70 mm. long. The actinostomal membrane and buccal plates are lacking, but it appears to belong to this species and doubtless came from the Mediterranean.

3. *Centrostephanus rogersii*.

Thrichodiadema rogersii A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 354.

Centrostephanus rogersii A. Agassiz, 1872. Rev. Ech., pt. 1, p. 98. 1873, Rev. Ech., pt. 3, pl. III f, figs. 1-3.

Size very large, up to 100 mm. or more in diameter ; colour uniform, deep reddish-purple ; in very young ones primaries are banded with white.

17 specimens. Localities represented are : Queensland, Port Denison ; New South Wales, Bondy Head ; N.S.W., near Sydney ; N.S.W., Port Jackson. The specimen from Port Denison is labelled *Diadema setosum*, and 4 small ones from Port Jackson bear the surprising name *Strongylocentrotus erythrogrammus*.

Most of these specimens are very large typical examples, but the one from Port Denison is only 21 mm. in diameter, and has the primaries banded with dull reddish and reddish-white much as in young *Diadema savignyi*. Some specimens from Port Jackson are a little larger than this, 27-28 mm. in diameter, with the primaries 30-35 mm. long : some of them are unicoloured, but others still show the light bands.

4. *Centrostephanus rubricingulus*.

H. L. Clark, 1921. Univ. Iowa Stud. Nat. Hist., 9, no. 5, p. 108, pl. I.

Small primary spines on uppermost coronal plates with brilliant rose-purple (rhodamine) tips : primary spines banded.

1 specimen from the north coast of Porto Rico, 40-49 fms.

This is the second known specimen of the only West Indian species of the genus. It is 10 mm. in diameter, a trifle smaller than the holotype from Barbados, from which it differs in that the red of the primary spines is distinctly a violet-red. The small abactinal primary spines (on the uppermost plates adjoining the genito-ocular ring), with their brilliant rhodamine tips, are the most striking feature of this little urchin, and taken in connexion with the spines on the buccal plates, set it off sharply from young *Diademas* of similar size. Though the specimen is in excellent condition, no globiferous pedicellariae could be found.

7. COENOPEDINA.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 256.

Type, *Coenopedina cubensis* A. Agassiz, 1869. Bull. M.C.Z., 1, p. 256.

Test firm and hard : periproct fully plated : primary spines large, solid ; colours bright.

1. *Coenopedina superba* sp. nov. PLATE V, figs. 1 and 2.

Test 35 mm. in diameter and 17 mm. high. Coronal plates 6 or 7 in each column, with rather few small tubercles. Ambulacral plates 16 or 17 in each column, with only one secondary tubercle on each. Abactinal system 15 mm. across, with the periproct a trifle more than half of it : ocular III with one small spine close to the pore : no spines or pedicellariae on the other oculars. Genital plates much larger than, and completely excluding, all the oculars ; pores large, just a little distal to the centre : inner margins with 4 or 5 small spines and a few pedicellariae, but otherwise the plates are bare and smooth. Periproct covered by very numerous small plates. Actinostome 15 mm. across, with the buccal plates moderately large and carrying small spines as well as tridentate and ophicephalous pedicellariae : many other plates in the buccal membrane carry tridentate pedicellariae.

Primary spines 25-50 mm. long, their thickness 6-10 per cent. of their length, blunt or truncate at tip. No globiferous pedicellariae were found either in the holotype or in the smaller specimens : tridentate and ophicephalous are abundant, but are not distinctive in any way.

Colour of test reddish-white abactinally, but the periproct is pure white, as is the oral side of the test and the peristome; uppermost ambulacral plates, an ill-defined area around the ocular pore, and all the small spines are dull red; orally some of the small spines are more or less white distally. Primary spines pure white basally, becoming greenish distally; some are distinctly green-tipped. Tube-feet pure white orally, but becoming dull purple abactinally. Pedicellariae pure white.

Saya de Malha Banks, 150 fms. (*Gardiner*). 3 specimens.

The two paratypes are much smaller than the specimen just described, 20 mm. in diameter by 11 mm. high; on one the primary spines are 17–27 mm. long, and in the other they attain a length of 35 mm. The coloration is surprisingly different from that of the holotype, but is no doubt associated with their youthfulness. In both the test and pedicellariae are pure white, but the small spines are green, and the primaries, though white with a greenish tinge *basally*, are banded with pale dull red. In the specimen with the shorter spines each primary has one or two broad ill-defined bands, but in the other the longer primaries have 3 bands of the dull red. Apparently in this species, as in *Diadema* and in *Centrostephanus rogersii*, the young have banded primaries, which become unicoloured in the adult. But in *Diadema* and *Centrostephanus* the unicoloured condition is attained by increase of pigment, with consequent loss of the light areas, whereas in *Coenopedina* the pigmented areas disappear.

This beautiful sea-urchin appears to be more nearly related to *C. cubensis* of the West Indies and Atlantic Ocean than to *C. capensis* or any of the Pacific species. The very stout primary spines (banded in the young), the relatively larger actinostome and the coloration set it apart easily from *C. cubensis*, and even more readily from the other species.

Family 3. ECHINOTHURIIDAE, Wyville Thomson.

Ambulacral plates compound; test flexible; primordial interambulacral plates present; peristome fully plated with series of ambulacral plates.

The collection of Echinothurids, numbering over 140 specimens of 24 species, is a fairly representative one. As much of it has been studied by Agassiz and by Mortensen, there is little new information to give. Some of the original *Challenger* labels, as well as those of Agassiz, have been misplaced, leaving some doubt as to the localities from which certain specimens came and as to the names given to them by Agassiz. Some of the criticisms of Agassiz's work made by Mortensen (1903, *Ingolf* Ech., pt. 1, pp. 47–60) may be due to this. The

family is an unmistakable one, and the genera are fairly distinct and easy to recognize ; but the species limits in most of the genera, particularly *Echinosoma* and *Aracosoma*, are very hazy.

1. PHORMOSOMA.

Wyville Thomson, 1872. Proc. Roy. Soc. Edinburgh, 7, p. 617.

Type, *Phormosoma placenta* Wyville Thomson, 1872. Proc. Roy. Soc. Edinburgh, 7, p. 617.

Actinal tube-feet in a single more or less irregular series ; each primary ambulacral plate normally accompanied by 2 secondary elements ; abaetinal and actinal surfaces strikingly and abruptly unlike ; no ' hoofs ' on actinal spines.

1. *Phormosoma bursarium*.

A. Agassiz, 1881. *Challenger* Ech., p. 99, pl. X b.

Abaetinal primary tubercles similar, with spines smooth or at least not verticillate ; arcs of pores oblique abaetinally ; abaetinal primary tubercles not confined to peripheral half of test.

7 specimens, of which 2 have no locality labels. The others are from *Challenger* St. 200, Philippine Islands, 255 fms., mud ; and *Challenger* St. 205, north-west of the Philippine Islands, 1,050 fms., grey ooze.

2. *Phormosoma placenta*.

Wyville Thomson, 1872. Proc. Roy. Soc. Edinburgh, 7, p. 617.
1874. Phil. Trans. R. S., 164 (2), pl. LXII and pl. LXIII, figs. 1-8.

Abaetinal primary tubercles small and numerous ; spines not verticillate ; pore-pairs small in oblique arcs ; actinostome distinctly larger than abaetinal system.

20 specimens from the following localities : Davis Strait, 235 fms. ; Western Atlantic, 41° 33' 15" N., 65° 51' 25" W., 810 fms. ; 32° 40' N. × 76° 40' W., 731 fms. ; Eastern Atlantic, Irish Fish. Board St. 212, west from Valentia, Ireland, 411 fms., fine, muddy sand ; St. 499, south-west of Ireland, 666-778 fms. ; Bay of Biscay, 1,400 fms. ; 46 miles west of Cape Spartel, Morocco, 417 fms.

These are very typical examples, showing little diversity.

3. *Phormosoma rigidum*.

A. Agassiz, 1881. *Challenger* Ech., p. 104, pl. XII a, figs. 1-4.

Ambulacral pores large ; in a nearly vertical series, near outer end of plates.

2 specimens from *Challenger* St. 169, off New Zealand, 700 fms., grey ooze.

These are the type specimens, and have been re-examined

by Mortensen, with whom I agree that only more abundant material from the same region can determine the validity of the species.

2. ECHINOSOMA.

Pomel, 1883. Class. Meth. Ech., p. 108.

Type, *Phormosoma tenue* A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 202.

Actinal tube-feet in a single more or less irregular series; abactinal and actinal surfaces not abruptly and markedly different; some actinal primaries end in 'hoofs'.

1. *Echinosomea hoplacantha*.

Phormosoma hoplacantha Wyville Thomson, 1877. Voy. *Challenger*: The Atlantic, 1, p. 148. A. Agassiz, 1881. *Challenger* Ech., pl. XI, pl. XII, and pl. XII a, figs. 10-13.

Echinosomea hoplacantha Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 59.

Tube-feet abactinally in 3 series; valves of large tridentate pedicellariae strongly involute at middle; abactinal ambulacral plates only 2 or 3 times as numerous as actinal.

2 specimens, the holotype, and 1 from *Challenger* St. 300, vicinity of Juan Fernandez, 1,375 fms., globigerina ooze.

The larger of these is 312 mm. in diameter; Agassiz (1881, *Challenger* Ech., p. 101) referred to it as 'the largest sea-urchin with which I am acquainted'. It has no locality label, but there is little doubt that it is the holotype of the species, from *Challenger* St. 164 a off New South Wales, 410 fms., green mud, for Thomson says that that specimen was a foot in diameter. This very important specimen is still in superb condition.

The individual from St. 300 is only 125 mm. in diameter, and the species characters in the test are not evident, but the pedicellariae seem to be like those of the type. With this specimen are 4 labels, 2 in Agassiz's hand and 2 apparently of Wyville Thomson's. Thomson's labels are both '*hoplacantha*', but one of Agassiz's reads '*hoplacantha*' and the other '*luculentum*'. The test characters are certainly those of the latter species. The two species are probably distinct, but the line between them is at present very hard to see.

2. *Echinosomea luculentum*.

Phormosoma luculenta A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 201. 1881, *Challenger* Ech., pl. IX, pl. X, and pl. X a, figs. 3-7.

Echinosomea luculentum A. Agassiz and Clark, 1909. Mem. M.C.Z., 34, p. 160.

Like *E. hoplacantha*, but abactinal ambulacral plates 4-7

times as numerous as actinal, and abactinal spines are much less numerous.

3 specimens, 2 from the Arafura Sea and 1 from *Challenger* St. 200, near Philippine Islands, 255 fms., mud.

The specimens from the Arafura Sea are much too young to identify and may belong to *E. hoplacantha*; no characteristic pedicellariae were found. The specimen from St. 200 is a very fine one, and may well be considered the type of the species although it is not so designated. It is the one examined by Mortensen with reference to the pedicellariae. The light red-violet colour and the red spines of the oral region make it look very different from *E. hoplacantha*, but I am not sure that the two species are really distinct.

3. *Echinosoma petersii*.

Phormosoma petersii A. Agassiz, 1880. Bull. M.C.Z., 8, p. 76. 1883, Mem. M.C.Z., 10, No. 1, pl. X and pl. XI (as *Phormosoma uranus*).

Echinosoma petersii A. Agassiz and Clark, 1909. Mem. M.C.Z., 34, p. 160.

Tube-feet abactinally in 1 or 2 series; abactinal surface well covered with spines; ambulacra and actinostome moderate; valves of tridentate pedicellariae curved, involute at middle.

6 specimens, 1 from *Albatross* St. 2,204, western Atlantic, off New Jersey coast, 728 fms., brown mud, and 5 from southwest of Ireland, 1,000 fms.

The specimen from the *Albatross* station is a fine large one, labelled *Phormosoma uranus*; but it has the peculiar large tridentate pedicellariae characteristic of *E. petersii*. The specimens from off Ireland are 85–130 mm. in diameter, deep purple in colour (but badly rubbed), and have the characteristic pedicellariae.

4. *Echinosoma tenue*.

Phormosoma tenue A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 202. 1881, *Challenger* Ech., pl. XIII and pl. XIV.

Echinosoma tenue Pomel, 1883. Class. Meth., p. 108.

Tube-feet abactinally in 1 or 2 series; abactinal surface with few spines; valves of tridentate pedicellariae not involute at all.

13 specimens from the *Challenger* collection; 10 are from St. 237, off Japan, 1,875 fms., mud, and 2 are from St. 232, off Japan, 345 fms., sandy mud.

The specimens from St. 237 are the types of the species. One, 200 mm. in diameter, is in fine condition, but the other nine are smaller and are more or less rubbed or bleached, the colour appearing as a light brown, not purple. The 2 speci-

mens labelled St. 232 are considerably bleached, and I suspect the locality label is wrong; it should probably be 237. A specimen from an unknown station is in very good condition; it is 200 mm. in diameter, and is of a deep brown-violet colour.

5. *Echinosoma uranus*.

Phormosoma uranus Wyville Thomson, 1877. *Voy. Challenger*: The Atlantic, 1, p. 146, figs. 33 and 34.

Echinosoma uranus Pomel, 1883. *Class. Meth.*, p. 108.

Very similar to *E. petersii*, but the valves of the tridentate pedicellariae are rather flat, not involute at middle.

2 specimens from *Challenger* St. VI, south-west of Portugal, 1,525 fms., globigerina ooze. Also 1 very young specimen from *Challenger* St. 78, eastern Atlantic, 1,000 fms., globigerina ooze.

One specimen from St. VI is in very poor condition, but the other, which may well serve as the type of the species, is fairly good. The small and few tube-feet and the moderately numerous but small abactinal primaries, in contrast to the few big actinal primaries, give *E. uranus* a characteristic appearance. The type has lost most of its colour.

The specimen from St. 78 is only 7 mm. across and is absolutely unidentifiable, as Mortensen (1903, *Ingolf* Ech., pt. 1, p. 58) has already stated.

6. *Echinosoma zealandiae*.

Phormosoma zealandiae A. Agassiz, 1904. *Mem. M.C.Z.*, 31, p. 105, pl. LI, figs. 1-4.

Echinosoma zealandiae A. Agassiz and Clark, 1909. *Mem. M.C.Z.*, 34, p. 168.

Abactinal tube-feet in 1 or 2 rows; actinostome very large, with deep gill cuts.

1 specimen from *Challenger* St. 169, off New Zealand, 700 fms., grey ooze. Labelled and catalogued (1904-12-2-12) as *Asthenosoma gracile*.

This, the holotype of the species, was received from Agassiz in 1904, after the publication of his detailed description and figures. As the specimen is only 24 mm. in diameter it is impossible to feel sure that it is not the young of either *E. hoplacantha*, *luculentum* or *tenuis*. No distinctive pedicellariae were found. It is interesting to note that this unique holotype is from the same station as the young specimens, on which *Ph. rigidum* is based. No adult Echinothurids were taken at that station, nor has any been taken near New Zealand, since the *Challenger's* day, save the Araeosomas secured by the *Terra Nova*, but they are shallow-water forms.

3. KAMPTOSOMA.

Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 60.

Type, *Phormosoma asterias* A. Agassiz, 1881. *Challenger* Ech., p. 104.

Primary ambulacral plates each accompanied by a single secondary element or none; actinal tube-feet in a single series.

1. *Kamptosoma asterias*.

Phormosoma asterias A. Agassiz, 1881. *Challenger* Ech., p. 104, pl. XII a, figs. 7-9.

Kamptosoma asterias Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 60.

9 specimens from 3 *Challenger* stations: St. 272, central Pacific, 2,600 fms., radiolarian ooze; St. 274, central Pacific, 2,750 fms., radiolarian ooze; St. 299, off the coast of Chile, 2,160 fms., grey mud. Most of these specimens are labelled *Phormosoma tenue*.

These specimens range from 18 to 50 mm. in diameter, and look very much like young *E. tenue*. The type specimen is 30 mm. in diameter; it comes from St. 299; it has been amply discussed by Agassiz and by Mortensen. A single example from St. 274 is 28 mm. in diameter and has characteristic pedicellariae. The 7 specimens from St. 272 serve well to show that the ambulacral characters by which *K. indistinctum* A. Ag. was supposed to be distinguished cannot be relied on: the marginal actinal spines are flattened and widened at the tip as in the type of *K. asterias*. I find no reason to doubt that all of the specimens from St. 272 belong to *K. asterias*, probably the most abyssal of all regular Echinoidea, although some of the Spatangoids rival it in the depth at which they live.

4. ASTHENOSOMA.

Grube, 1868. 45^{er} Jahres-Bericht d. Schlesische Gesellsch., p. 42.

Type, *Asthenosoma varium* Grube, 1868. 45^{er} Jahres-Bericht d. Schlesische Gesellsch., p. 42.

Actinal tube-feet in 3 series: each half of actinal ambulacra made up of 3 columns of plates; abactinal primary spines small, numerous, encased in loose skin-sheaths.

1. *Asthenosoma heteractis*.

Bedford, 1900. Proc. Zool. Soc. London, p. 278, pl. XXI, fig. 2.

Actinal primaries banded; abactinal ambulacral primaries banded with purple.

1 specimen from Singapore.

This is apparently the holotype; it is about 95 mm. in

diameter. The test is much firmer than in *A. varium*, and it is darker coloured and has the bare spaces of the interambulacra more conspicuous than in that species, but I very much doubt whether *A. heteractis* is a valid species.

2. *Asthenosoma urens*.

Cyanosoma urens P. and F. Sarasin, 1886. Zool. Anz., 9, p. 80.

Asthenosoma urens P. and F. Sarasin, 1888. Ergebn. Nat. Forsch. Ceylon, 1, p. 86, pls. X-XVII.

Actinal primaries banded: abactinal ambulacral primaries longer than interambulacral, but not very unlike them in colour; naked radial areas of abactinal surface conspicuous.

9 specimens, of which 3 are from Maldive Islands, Mulaku (*Gardiner*), and 6 are from Ceylon, Trincomali Harbour.

The 3 specimens from the Maldives are 75-90 mm. in diameter, and their coloration is essentially that of *A. heteractis*. But the specimens from Ceylon are very different, for they are so dark as to appear almost black, especially on the upper surface, and the ambulacral spines are banded blackish and lighter; apart from this striking coloration, which is shown by all 6 of the specimens, I find no character by which they can be distinguished from *A. heteractis*.

3. *Asthenosoma varium*.

Grube, 1868. 45^{er} Jahres-Bericht d. Schlesische Gesellsch., p. 42.

A. Agassiz, 1881. *Challenger* Ech., pls. XV-XVII (as *Asthenosoma grubei*).

Very similar to *A. urens*, but naked radial areas of abactinal surface very narrow or even wanting.

2 specimens from the *Challenger* collection; 1 from Zamboanga, the other listed as from St. 300, an impossible locality for this species.

These are good specimens, types of Agassiz's *A. grubei*, the identity of which with *A. varium* appears to be beyond question. Indeed, the somewhat scanty material of *Asthenosoma* that I have examined leads me to doubt very much if there is (except *A. ijimai* Mortensen, which I have not seen) more than one species in the genus, for which of course Grube's name would take precedence.

5. *ARAEOSOMA*.

Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 53.

Type, *Calveria fenestrata* Wyville Thomson, 1872. Proc. Roy. Soc. London, 20, p. 494.

Actinal tube-feet in 3 more or less distinct rows; abactinal surface with at least 30 primary tubercles; abactinal primary spines not encased in loose skin-sheaths.

1. *Araeosoma belli*.

Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 55. 1910, Bull. U.S. Nat. Mus., 74, pl. XI and pl. XII, fig. 1.

Ambulacra moderately wide; ambulacral plates rather high and few; test violet above, often lighter below.

1 specimen from off Barbados, 137 fms.

This is the holotype of the species, which was amply described and figured by Mortensen in 1910.

2. *Araeosoma coriaceum*.

Asthenosoma coriacea A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 201. 1881, *Challenger* Ech., pl. XVII a, figs. 5-7.

Araeosoma coriaceum Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 53.

Large; colour greenish-black, blackish-brown or dark grey; actinal primaries with very small hoofs; coronal plates with wide interspaces of leathery skin.

2 specimens, from the *Challenger* collection; one from St. 173, near Fiji Islands, 310-315 fms., the other is labelled 'North-east of New Zealand, 700 fms.', almost certainly a misplaced label.

These specimens, some 200 mm. in diameter or more, are in fine condition and are very good examples of the species. It is quite possible that the one labelled as from New Zealand is that listed in the *Challenger* Report as from St. 172 (off Tongatabu, 240 fms.), for I have not found any Echinothurid from St. 172 in the Museum, and the specimen of *A. coriaceum* in the Museum of Comparative Zoölogy is from St. 173. In the British Museum specimens the abactinal interambulacral plates are not at all bent as they are in the M.C.Z. specimen; this bending must be either an individual peculiarity or an artifact. The general appearance of this species is very characteristic: the greenish-black colour is quite different from that of any of its allies, and the actinal primaries have hoofs which seem disproportionately small.

3. *Araeosoma fenestratum*.

Calveria fenestrata Wyville Thomson, 1872. Proc. Roy. Soc. London, 20, p. 494. A. Agassiz, 1883. Mem. M.C.Z., 10, No. 1, pl. XIII and pl. XIV (as *Asthenosoma hystrix*).

Araeosoma fenestratum Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 52. 1910, Bull. U.S. Nat. Mus., 74, pl. XII, fig. 2.

Large; leathery spaces between coronal plates evident; colours dull but not dark; abactinal ambulacral plates not much more numerous than actinal.

28 specimens from the following localities: North Sea; Ireland, off west coast, 500 fms.; Ireland, 45 miles off Black-

rock, 500 fms.; Ireland, Irish Fisheries Board St. 222, west from Arran Islands, 293 fms., fine sand; Bay of Biscay; *Albatross* St. 2,624, off coast of South Carolina, 258 fms., sand. The specimens from 500 fms. off the west coast of Ireland, and those from off Blackrock, were labelled *Asthenosoma hystrix*.

The specimens from Irish F. B. St. 222 are somewhat rubbed, but most of this series is in excellent condition. It shows little diversity and indicates a well-defined species. The specimens range from 90–180 mm. in diameter. It is not easy to locate the ambitus exactly in the largest specimen, but there seem to be 40–42 abactinal plates in the ambulacra in each column, and 36–38 on the actinal side.

4. *Araeosoma gracile*.

Asthenosoma gracile A. Agassiz, 1881. *Challenger* Ech., p. 89, pl. XVII a, figs. 1–4.

Araeosoma gracile A. Agassiz and Clark, 1909. Mem. M.C.Z., 34, p. 191.

Small; test thin; colours dull; leathery interspaces between coronal plates small; abactinal ambulacral plates much more numerous than actinal; valves of large tridentate pedicellariae curved.

3 specimens from the *Challenger* collection: St. 184, off the Great Barrier Reef, northern Queensland, 1,400 fms., grey ooze; St. 200, Philippine Islands, 255 fms., mud; St. 219, Admiralty Islands, 150 fms., mud.

All of these specimens have been critically examined and discussed by Mortensen (1903, *Ingolf* Ech., pt. 1, pp. 51, 52). He accepts the specimen from St. 200 as the holotype of the species, and in view of Agassiz's comments on the others, this is undoubtedly correct. This specimen is 110 mm. in diameter and is in good condition.

The specimens from Sts. 184 and 219 were referred to *A. gracile* by Agassiz with carefully expressed doubt. Mortensen is much more emphatic and is very positive that they are not related closely to *A. gracile* nor to each other. In view of Mortensen's opinions I examined the specimens with particular interest. The specimen from St. 184 is only 19 mm. in diameter, and is much too young to be assigned to any species. In view of the depth at which it was taken, and the structure of the pedicellariae as described by Mortensen, it is probably not nearly related to *A. gracile*. All that can be asserted of it is that it is a young Echinothurid. The specimen from St. 219 is 31 mm. in diameter; the test is very bare, much rubbed, and with little colour; the few spines that are present are colourless. Aside from the matter of the pedicellariae, there is no evident reason why this individual might not be named *A. gracile*. Consideration of the pedicellariae

shows that the triphyllous are virtually identical with those of *A. gracile*, but the tridentate are sufficiently different to make one hesitate. When we consider, however, that we are trying to compare a very young specimen in poor condition with an adult specimen from a different locality, we may well pause before we let so trivial and uncertain a factor determine the conclusion. It may well be that well-preserved specimens of *A. gracile* will show both kinds of tridentate pedicellariae, or a good series of specimens may show that the straight-valved form occurs in youth and the one with curved valves characterizes the adult. Under the circumstances I am inclined for the present to let the specimen from St. 219 remain under *A. gracile*. I quite agree with Mortensen (1904, Ann. Mag. Nat. Hist. (7), **14**, p. 86) that it cannot be considered a young example of *A. tessellatum*.

5. *Araeosoma hystrix*.

Calveria hystrix Wyville Thomson, 1872. Proc. Roy. Soc. London, **20**, p. 494. 1874, Phil. Trans. R. S., **164** (2), pl. LXIV and pl. LXV.

Araeosoma hystrix A. Agassiz and Clark, 1909. Mem. M.C.Z., **34**, p. 175.

Size moderate or large; colour bright red; ambulacra only moderately wide.

11 specimens, 1 of which has no locality label, and is labelled '*Phormosoma*'. Localities represented are: North Sea; Faroe Channel, St. 10, 516 fms., grey mud (*Triton*); Ireland, 45 miles off Blackrock, 500 fms.; Ireland, Irish F. B. St. 1,242, south-west of Ireland, 550-590 fms.

Most of these are very fine specimens with the brilliant red colour unimpaired.

6. *Araeosoma leptaleum*.

A. Agassiz and Clark, 1909. Mem. M.C.Z., **34**, pp. 175, 183, pls. LXXVI and LXXVII.

Ambulacra about four-fifths as wide as interambulacra; interambulacral plates about as numerous actinally as abactinally; colours dull.

1 specimen from Saya de Malha Banks, 300-500 fms. (*Gardiner*), labelled *Asthenosoma coriaceum*.

The test is not leathery as it is in *A. coriaceum*, and there is virtually no colour. The specimen is in poor condition, about 150 mm. in diameter, with the ambulacra about 40 mm. and the interambulacra about 50. The unique specimen upon which *A. leptaleum* was based came from the Gulf of Panama in 581 fms., and it is surprising to have the next known specimen collected on the Saya de Malha Banks in the Indian Ocean. I can find no good reason for not calling this specimen *A. leptaleum*, but I think that a good series of specimens from

Saya de Malha, compared with a similar series from Panama, might show specific differences.

7. *Araeosoma owstoni*.

Mortensen, 1904. Ann. Mag. Nat. Hist. (7), **14**, p. 82, pl. II and pl. V, figs. 4-9, 11, 18-20.

Colours dull ; ambulacra only moderately wide ; test rather stout ; coronal plates with small interspaces ; valves of big tridentate pedicellariae straight or nearly so.

2 specimens from Japan, Sagami Bay, 3 miles west of Misaki, 60 fms.

These specimens, 110 and 145 mm. in diameter, have been labelled by Mortensen and are apparently his types.

8. *Araeosoma pellucidum*.

Asthenosoma pellucidum A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 200. 1881, *Challenger* Ech., pl. XIX, figs. 1-6.

Araeosoma pellucidum A. Agassiz and Clark, 1909. Mem. M.C.Z., **34**, p. 175.

Size small ; ambulacra very narrow ; primary spines near ambitus prettily banded with red or reddish-purple.

7 specimens from the *Challenger* collection ; St. 192, near the Kei Islands, 129 fms. ; Philippine Islands, near Cebu, 100 fms.

This is the prettiest and most delicate of the Echinothurids, and seems to be the smallest. The largest of the British Museum specimens is 64 mm. in diameter.

9. *Araeosoma tessellatum*.

Asthenosoma tessellatum A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 201. 1881, *Challenger* Ech., pl. XIX a, fig. 1 and pl. XIX b.

Araeosoma tessellatum Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 54.

Size moderate ; colours dull ; interspaces between coronal plates very conspicuous ; abactinal coronal plates straight.

1 specimen from *Challenger* St. 204, near the Philippine Islands, 100-115 fms., mud.

This is the holotype and measures 140 mm. in diameter. The pedicellariae have been carefully described by Mortensen.

10. *Araeosoma thetidis*.

Asthenosoma thetidis H. L. Clark, 1909. Bull. M.C.Z., **52**, p. 134.

Araeosoma thetidis A. Agassiz and H. L. Clark, 1909. Mem. M.C.Z., **34**, p. 175, pls. LXVIII-LXX.

Actinal interambulacral primary tubercles not forming an uninterrupted marginal series ; abactinal primary tubercles few and large ; colours dull.

3 specimens from New Zealand, 7 miles east of North Cape, 70 fms. (*Terra Nova*), labelled *Astropyga radiata*.

Mortensen (1921, Ech. New Zealand, Vid. Med., **73**, p. 153) has already called attention to the misidentification of these specimens. The occurrence of this species in New Zealand waters, especially on the eastern side of the islands, is very interesting; it is otherwise known only from the coast of south-eastern Australia.

11. *Araeosoma violaceum*.

Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 176. 1910, Bull. U.S. Nat. Mus., **74**, pl. XIII, fig. 1.

Colour, including actinal primaries (except hoofs) deep violet; ambulacral plates low and numerous.

5 specimens from Ireland, deep water off County Mayo (*Irish Fisheries Board*).

These are Mortensen's types, which he records as from 'Porcupine' Bank, 199 fms. In 1913 Farran (Dept. Agr. Ireland, Fisheries Branch, Sci. Inv. 1912, No. VI, pp. 55 and 56) discusses the *Araeosomas* taken in the vicinity of Porcupine Bank, and decides that *A. violaceum* cannot be maintained as a species distinct from *A. fenestratum*, and he quotes Mortensen as agreeing with this conclusion. After examining the types I am inclined to retain the name, as it may prove to be a convenience for designating so easily recognized a form.

6. SPEROSOMA.

Koehler, 1897. Zool. Anz., **20**, p. 302.

Type, *Sperosoma grimaldii* Koehler, 1897. Zool. Anz., **20**, p. 302.

Each half of ambulacrum actinally consists of 4 columns of plates; the two median columns made up of secondaries, the inner and outer columns of halves of the original primary plates.

1. *Sperosoma grimaldii*.

Koehler, 1897. Zool. Anz., **20**, p. 302. 1898, *Hirondelle* Ech., pl. II and pl. III.

Abactinal ambulacral plates not twice as numerous as actinal: abactinal primary spines numerous: abactinal tube-feet few, in an imperfect double series.

1 specimen from south-west of Ireland, Irish F. B. St. S. R. 477, 707-710 fms., ooze.

This appears to be the specimen referred to by Farran (1913, Dept. Agr. Ireland, Fisheries Branch, Sci. Inv. 1912, No. VI, p. 54) as the first of the species recorded from British and Irish seas.

Suborder 2. *STIRODONTA*, Jackson.

Teeth keeled; epiphyses of lantern narrow; tubercles usually imperforate.

Family 1. SALENIIDAE, Desor.

Ambulacral plates largely simple, a few compound; teeth keeled; primary tubercles imperforate in all recent species; periproct with a permanent large suranal plate; size small; primary spines long and slender.

This small family is represented by fewer than 40 specimens, most of which are young, many so young that their identification is uncertain. Indeed, 2 are so small that I am unwilling to give them any specific name; both are *Challenger* specimens; 1 from off Cebu, 100 fms., was named *Salenia hastigera* (= *profundi*) by Agassiz, but I am doubtful whether it is that species; the other from St. 170 was also labelled *S. hastigera*, but it is too young to warrant the assignment.

1. *SALENIA*.

Gray, 1835. Proc. Zool. Soc. London, p. 58.

Type, *Cidarites scutigera* Goldfuss, 1829. Petrefacta, pt. 1, p. 121.

Ambulacral plates compound, made up of 2 elements.

1. *Salenia cincta*.

A. Agassiz and Clark, 1907. Bull. M.C.Z., 51, p. 116. 1908, Mem. M.C.Z., 34, pl. LVII, figs. 1-3.

Peristome about half of test diameter; primaries rather slender, with 12-16 narrow bands of dull red.

1 specimen from Japan, Misaki, 500 fms.

A superb example of this handsome species.

2. *Salenia pattersoni*.

A. Agassiz, 1878. Bull. M.C.Z., 5, p. 187. 1883, Mem. M.C.Z., 10, No. 1, pl. V.

Abactinal system light coloured, with plates outlined in deep violet; primary spines with 3-5 broad bands of bright red.

3 specimens, 1 from off Montserrat, 148 fms., and the others either from off Havana, Cuba, 175 fms., or from off Guadeloupe, 196 fms.

These are good adult specimens from the *Blake* collections. The Montserrat station is no. 158, the Guadeloupe station is no. 159, and the Havana station is apparently no. 56. I am inclined to think that the specimens of uncertain station are from Guadeloupe (the label *on* the jar) rather than from Havana (the label *in* the jar).

2. SALENOCIDARIS.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 254.

Type, *Salenocidaris varispina* A. Agassiz, 1869. Bull. M.C.Z., 1, p. 254.

Ambulacral plates, except for one or two near peristome, simple; abactinal system covered with small rough tubercles, its plates not clearly separated from each other.

1. *Salenocidaris miliaris*.

Salenia miliaris A. Agassiz, 1898. Bull. M.C.Z., 32, p. 74. 1904.

Mem. M.C.Z., 31, pls. XIV, figs. 3-11, XV, figs. 1 and 2.

Salenocidaris miliaris A. Agassiz and Clark, 1908. Mem. M.C.Z., 34, p. 60.

Primary spines long, slender, verticillate; size relatively large, diameter sometimes exceeding 16 mm.; coronal plates 6-8; vertical diameter two-thirds of horizontal; ocular 1 usually insert.

2 specimens, from *Albatross* St. 3,407, Galapagos Islands, north-east of James Island, 885 fms., globigerina ooze, and from *Challenger* St. 195, Banda Sea, 1,425 fms., grey ooze.

The specimen from the Galapagos Islands is a cotype. That from the Banda Sea was labelled *S. hastigera* by Agassiz, but in my opinion should be referred to *S. miliaris*. It is a bare test, in good condition, accompanied by the primary spines.

2. *Salenocidaris profundi*.

Salenia profundi Duncan, 1877. Ann. Mag. Nat. Hist. (4), 20, p. 70. A. Agassiz, 1881. *Challenger* Ech., pl. IV, figs. 3-17 (as *Salenia hastigera*).

Salenocidaris profundi A. Agassiz and Clark, 1908. Mem. M.C.Z., 34, p. 60.

Primary spines long; vertical diameter about half of horizontal; size moderate; coronal plates 6 or 7; ocular 1 exsert.

24 specimens, of which 2 have no locality, 1 of them evidently Duncan's specimen and probably the holotype of the species, the other a *Challenger* specimen. Localities represented are: Bay of Biscay, *Challenger* coll. (the *Challenger* made no collections in the Bay of Biscay!); Bay of Biscay, 1,710 m. (= 950 fms.) (*Kochler*); *Challenger* St. 106, Tropical Atlantic, 1,850 fms., globigerina ooze; *Albatross* St. 2,127, Caribbean Sea, 1,639 fms., green mud; *Blake* St. 140, off Virgin Gorda, 1,097 fms.; Brazil, off Macio, 1,700 fms. (*Challenger*); *Challenger* St. 335, South Atlantic, 1,425 fms., globigerina ooze; *Challenger* St. 171, north-east of Kermadec Islands, 600 fms., rocks; *Challenger* St. 195, Banda Sea, 1,425 fms., grey ooze.

This interesting series has convinced me that very young specimens of *S. profundus*, *S. miliaris* and *S. varispinus* cannot certainly be distinguished from each other. All but two of the specimens are from the Atlantic Ocean, and the question naturally arises whether the two Pacific specimens should not be referred to *S. miliaris*: one from north-east of the Kermadecs is young and may be *S. miliaris*, but the one from the Banda Sea is a fine adult and is apparently an indubitable *S. profundus*. But the lines between *S. profundus* and *S. miliaris* on the one hand, and between *S. profundus* and *S. varispinus* on the other, seem to be artificial, and they might be treated as a single species.

Some of the difficulties to be found in trying to maintain the three forms are as follows: The *Challenger* specimen without locality label is a superb one, 16 mm. in diameter with primaries 50–55 mm. long; in each ambulacral series there are 5 large (as in *varispinus*) and 14 small (as in *profundus*) tubercles. Again, the *Albatross* specimen was identified by Agassiz as *S. varispinus*, but seems to me to be *S. profundus*. The character of the abactinal system supposed to distinguish *S. miliaris* is inconstant. Until larger series of adults are available the use of the three names may be continued.

3. *Salenocidaris varispinus*.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 254. 1872, Rev. Ech., pt. 1, pl. III, figs. 8–14 (as *Salenia varispinus*).

Primaries long, prickly, slender; size small, rarely over 10 mm. in diameter; coronal plates 7–9; ocular I exsert; 3–6 large primary tubercles in each ambulacral series actinally, and 7–10 smaller ones abactinally.

7 specimens from the following localities: Sts. 23, West Indies, off Sombrero Island, 450 fms., globigerina ooze, and 24, W.I., off Leulebra Island, 390 fms., mud (*Challenger*); St. 211, off Martinique, 357 fms. (*Blake*); Sts. 78, south-east of the Azores, 1,000 fms., globigerina ooze, 122, off Brazil, 350 fms., mud, and 344, off Ascension Island, 420 fms. (*Challenger*).

Except the specimen from Station 344, these are too young for satisfactory identification.

Family 2. STOMOPNEUSTIDAE, Mortensen.

Teeth keeled; primary tubercles imperforate; ambulacral plates compound, composed of 3 elements, but in the midzone every 4 or 5 such plates are united and overgrown by 1 large primary tubercle.

The single known species has a wide range, and the chief interest of the specimens in the British Museum is the places from which they come. Some from Mauritius reveal an extraordinary modification of the primary spines.

1. STOMOPNEUSTES.

Agassiz, 1841. Mon. Ech., Anat. Echinus, p. x.

Type. *Echinus variolaris* Lamarek, 1816. Anim. s. Vert., 3, p. 47.

Test large, stout; primary tubercles conspicuous; primary spines stout.

1. *Stomopneustes variolaris*.

Echinus variolaris Lamarek, 1816. Anim. s. Vert., 3, p. 47.

Stomopneustes variolaris Agassiz, 1841. Mon. Ech., Anat. Echinus, p. x. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. IV b, figs. 1-3.

Colour very dark, greenish or purplish-black.

32 specimens, of which 12 are bare tests, and 10 are without locality. Localities represented are: Socotra; British East Africa, Wasin Island, 10 fms. (*Crossland*); German East Africa; G.E.A., Dar-es-Salaam; Mauritius; India; India, Tuticorin; India, Vizagapatam; India, coast of Sind; Burmah; Samoa; Samoa, Upolu.

The largest of this good series is from Tuticorin. It is 95 mm. in diameter and 50 mm. high; the primaries are 72 mm. long. The specimens from Mauritius show a surprising diversity in the character and length of the primary spines. A very fine specimen, 67 mm. in diameter, has primary spines 67 mm. long and 2-3 mm. in diameter near the base, and another 80 mm. in diameter has the primaries 60-65 mm. in length. But a specimen 90 mm. in diameter has the primaries only 20 mm. long, and another, 77 mm., has numerous primaries measuring 12-15 mm. long and 1-2 mm. in diameter at base. Another specimen 72 mm. in diameter has the spines only 15-25 mm. long but they are 3-5 mm. in diameter. These specimens with short, stout spines recall specimens of *Strongylocentrotus droebachiensis* from the coast of Maine, which live on exposed reefs or ledges, where the tide runs very strongly or the surf beats heavily; these have flatter tests and shorter, stouter spines than specimens from quieter water. I suspect that these short-spined *Stomopneustes* come from similar exposed situations. They show no modification of the test correlated with the shorter spines.

Family 3. ARBACIIDAE, Gray.

Teeth keeled; ambulacral plates compound, with 3-5 elements in each plate; primordial interambulacral plates present; periproct with (normally) 4 or 5 equal plates; primary tubercles imperforate.

There are more than 160 specimens of this small family in the Museum, nearly all in condition to permit of satisfactory identification; very young are, as a rule, associated with older

specimens. 13 species are represented, a few by plentiful material, which throws much light on the distribution and the diversity of the species. The 7 genera into which the family is conveniently and naturally divided are of quite unequal size, for 3 are monotypic and 2 others have but 2 species each; *Arbacia* with 6 species and *Coelopleurus* with 4 complete the group. The genera *Arbacia*, *Tetrapygyus* and *Coelopleurus* are well known, but *Pygmacoidaris*, *Dialithocidaris*, *Podocidaris* and *Habrocidaris* are very rare, and it is doubtful if twenty-five specimens of the four genera can be found in all the museums of the world.

1. ARBACIA.

Gray, 1835. Proc. Zool. Soc. London, p. 58.

Type, *Cidaris pustulosa* Leske, 1778 = *Echinus lixula* Linné, 1758. Sys. Nat., ed. 10, p. 664.

Primary spines short, cylindrical or flattened near tip; test stout; abactinal surface with numerous articulated primary spines; ambulacral plates with 3 pairs of pores.

1. *Arbacia crassispina*.

Mortensen, 1910. Swedish S. Polar Exp. Ech., p. 32, pl. V, figs. 1-3.

Bare interambulacral areas dark green; ocular plates very small, narrow, and not concave on distal margin; abactinal interambulacral tubercles and spines numerous.

2 specimens from Tristan da Cunha, Nightingale Island, *Challenger* coll.

These are large and very handsome specimens of this species, which Mortensen based on a single *Challenger* specimen received from the British Museum. This type is 45 mm. in diameter, and the larger of these two is 62 mm. It resembles a specimen of *A. spatuligera* of equal size, but the primary spines are not so long, and the bare interambulacral areas, though dark, are distinctly green. The two specimens agree well with Mortensen's description, but I am not sure that more material from Tristan da Cunha would not show connecting links with *A. dufresnii*.

2. *Arbacia dufresnii*.

Echinus dufresnii de Blainville, 1825. Dict. Sci. Nat., 37, p. 76.

Arbacia dufresnii Gray, 1835. Proc. Zool. Soc. London, p. 38.

Mortensen, 1910. Swedish S. Polar Exp. Ech., pl. V, figs. 4-12.

Bare interambulacral areas bright green or green with a brownish cast, or brown with a distinct green tinge; ocular plates large, wide, and concave distally; abactinal interambulacral tubercles and spines few.

30 specimens, from the following localities: Strait of Magellan, Otter Island, Shell Bay, Port Rosario, Sandy Point, Trinidad Channel, 30 fms., Portland Bay, 10 fms., Port Otway, Tom Bay, and Cockle Cove, 2-32 fms., mud (*Alert*); Tierra del Fuego; St. 308, Chile, near Chatham Island, 175 fms., mud, and St. 304, Chile, near Taytao Peninsula, 45 fms., sand (*Challenger*).

This is a wonderful series of this handsome and interesting sea-urchin, and throws much light on the limits of its diversity. It is remarkable that the species is not known from the Falkland Islands, although a very closely related (if not identical) form (*A. crassispina*) occurs fully two thousand miles to the east at Tristan da Cunha. Some of the specimens in the present series approach *A. crassispina*: one from Portland Bay has the primary spines exceptionally stout, as in *A. crassispina*. The specimen from *Challenger* St. 304 is 46 mm. in diameter, with primary spines 40 mm. long; it is very brown, so brown that practically no green is visible. In the fine series of 10 specimens from Cockle Cove there is much diversity in the shade of the green; it ranges from bright yellow-green to deep green and even to pale brownish-green.

The specimen from Trinidad Channel is labelled *A. alternans* and I fully endorse Mortensen's conclusion (1910, Swedish S. Polar Exp. Ech., p. 31) that this name is a synonym of *A. dufresnii*. I believe Mortensen is also correct in maintaining that Troschel's species *A. africana* has nothing to do with *A. dufresnii*, but is almost certainly a synonym of *A. livula*. The confusion of *A. africana* with *A. dufresnii* is associated with the supposed occurrence of the latter on the coast of West Africa. There are in the collection of the Museum of Comparative Zoölogy 2 bare tests of an *Arbacia* that seem to be typical *A. dufresnii*: these are supposed to have come from the African coast. But it is much more probable that in some way these bare tests of *A. dufresnii*, originally from southern South America, became mixed with material from Liberia, and thus have been incorrectly labelled as from that region.

3. *Arbacia incisa*.

Echinocidaris incisa A. Agassiz, 1863. Bull. M.C.Z., 1, p. 20.

Arbacia incisa H. L. Clark, 1913. Bull. Amer. Mus. Nat. Hist., 32, p. 220. (No figure extant, but scarcely distinguishable in a photograph from *A. punctulata*.)

Oculars small, usually all² exsert; primary tubercles few; plates of abactinal system and bare interambulacral areas so finely granular as to appear velvety, prettily marked with deep red in contrast to the grey or whitish ground-colour.

5 specimens, of which 4 are bare tests without locality, and 1 has the incorrect label 'California'.

This is a poor representation of this Mexican and Central

American, west coast, species ; but the bare tests are particularly easy to recognize from their characteristic coloration.

4. *Arbacia lixula*.

Echinus lixula Linnaeus, 1758. Syst. Nat., ed. 10, p. 664.

Arbacia lixula Lovén, 1887. Bih. Svensk. Vet.-Akad. Handl., 13 (4), No. 5, p. 112. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. I g, fig. 5 (as *A. pustulosa*).

Oculars small, usually exsert ; primary tubercles numerous ; bare abactinal areas greatly reduced or even wanting.

46 specimens, of which 11 are bare and 27 are without locality labels. Localities represented are : Spain, Mahon ; Gibraltar ; Mediterranean Sea ; Italy, Naples ; France, Nice ; Marseilles ; Madeira Islands ; 'Azores or Madeiras' ; Cape Verde Islands, St. Vincent (*Challenger*) ; Gold Coast. Several specimens without locality were labelled *Echinocidaris grandinosa* or *E. aequituberculata* ; the specimen from Marseilles was labelled *Strongylocentrotus lividus*, and one without locality was named *S. droebachiensis*.

The most interesting specimens are those from the Gold Coast, the type locality for Tröschel's *A. africana*. These two individuals greatly resemble *A. punctulata*, especially in their light red-brown colour. In this particular they are as different from *A. africana* as they are from European specimens of *A. lixula*. I have little doubt that *A. africana* is a synonym of *A. lixula*.

5. *Arbacia punctulata*.

Echinus punctulatus Lamarck, 1816. Anim. s. Vert., 3, p. 47.

Arbacia punctulata Gray, 1835. Proc. Zool. Soc. London, p. 38.

A. Agassiz, 1872. Rev. Ech., pt. 1, pl. II, fig. 4.

Similar to *A. incisa*, but granulation much coarser and there are no red markings.

22 specimens, of which 14 are bare tests and 5 are without locality. Localities represented are : Massachusetts ; Rhode Island, Newport ; Connecticut, Noank ; South Carolina ; Georgia ; Florida. The last was labelled *A. stellata*.

6. *Arbacia spatuligera*.

Echinus (Agarites) spatuliger Valenciennes, 1846. Voy. Vénus, pl. V, fig. 2.

Arbacia spatuligera A. Agassiz, 1872. Rev. Ech., pt. 1, p. 93.

H. L. Clark, 1910. Bull. M.C.Z., 52, pl. X, fig. 2.

Oculars large, 1, 2 and often 3 in contact with periproct ; size large ; no green or red.

3 specimens, 1 bare and without locality, 2 from Chile, Coquimbo.

This species is imperfectly known, and a large series, of all ages, is needed to make its specific characters clear. The present specimens are adult, and there is no doubt as to their identity.

2. TETRAPHYGUS.

L. Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 354.

Type, *Echinus niger* Molina, 1872. Saggio St. Nat. Chile, p. 175.

Spines and tubercles numerous; ambulacral plates in mid-zone with 4 or 5 pairs of pores.

1. *Tetrapygyus niger*.

Echinus niger Molina, 1782. Saggio St. Nat. Chile, p. 175.

Echinocidaris (Tetrapygyus) nigra Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 354.

Tetrapygyus niger A. Agassiz and Clark, 1908. Mem. M.C.Z., 34, p. 73. H. L. Clark, 1910. Bull. M.C.Z., 52, pl. X, fig. 1.

Size large; colour black, usually with a violet or purple tinge.

29 specimens, of which 22 are bare tests and 22 are without locality labels. Localities represented are: Chile; Chile, Caldera; Chile, Coquimbo.

3. PODOCIDARIS.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 258.

Type, *Podocidaris sculpta* A. Agassiz, 1869. Bull. M.C.Z., 1, p. 258.

Abactinal surface with numerous short non-articulated spines; primary spines flattened; anal plates 4; tridentate pedicellariae small.

1. *Podocidaris sculpta*.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 258. 1872, Rev. Ech., pt. 1, pl. IV, figs. 8-16.

Spines not banded; tubercles on abactinal system few, low and not arranged in any definite pattern.

1 specimen from *Challenger* St. 24, West Indies, off Culebra Island, 390 fms., mud.

This is a bare test, 6 mm. in diameter; although only half grown, it shows clearly the characteristic features of the abactinal surface.

4. PYGMAEOCIDARIS.

Döderlein, 1905. Zool. Anz., 28, p. 622.

Type, *Podocidaris prionigera* A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 199.

Abactinal system very large; anal plates 5; test stout; primary spines flattened with serrate edges.

1. *Pygmaeocidaris prionigera*.

Podocidaris prionigera A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 199. 1881, *Challenger* Ech., pl. XXXIV, figs. 14 and 15.

Pygmaeocidaris prionigera Döderlein, 1905. Zool. Anz., **28**, p. 622.

Test without ornamental pits, brownish-yellow; primary spines slender.

2 specimens from St. 205, Philippine Islands, 1,050 fms., grey ooze, and St. 218, between New Guinea and the Admiralty Islands, 1,070 fms., globigerina ooze (*Challenger*).

These are the types described by Agassiz. The one from St. 205 is 6 mm. in diameter; the other, 9½ mm. in diameter, is in particularly fine condition.

5. COELOPLEURUS.

Agassiz, 1840. Cat. Sys. Ectyp. Ech., p. 19.

Type, *Cidaris coronalis* Leske, 1778. Add. ad Klein, p. 72.

Primary spines very long, much more than twice test diameter; 6–12 sphaeridial pits in each ambulacrum actinally.

1. *Coelopleurus elegans*.

Salmacis elegans Bell, 1899. Willey's Zool. Res., pt. II, p. 136.

Coelopleurus elegans A. Agassiz and Clark, 1908. Mem. M.C.Z., **34**, p. 83.

Coelopleurus maculatus A. Agassiz and Clark, 1907. Bull. M.C.Z., **51**, p. 116. 1908, Mem. M.C.Z., **34**, pls. LIII, figs. 1–7, LVII, figs. 4–6.

Primaries green marked with bright red; collar about one-twentieth of spine length, rough, with 12–15 longitudinal ridges.

16 specimens, from the following localities: Japan, Uraga Channel; Macclesfield Bank, 46 fms.; Amboina (*Challenger*); New Britain (*Willey*). These were labelled *C. maillardi*, except the one from Macclesfield Bank, which was labelled *Diadema saxatile*.

The specimen from New Britain is the most important in this series, for there is little doubt that it is the unique holotype of *Salmacis elegans* Bell, which was maintained as *Coelopleurus elegans* by Agassiz and myself on the assumption that the coloured figures given by Bell were accurate. The specimen is a young individual, 12 mm. in diameter, with broken spines; the colour is yellowish-green, not yellow as in Bell's figure, and the collar of the spines is quite as in *C. maculatus* Agassiz and Clark, which becomes a synonym.

The specimens from Japan and Amboina are typical examples of this beautiful urchin, but the one from Macclesfield Bank is peculiar and may perhaps be a young *C. longicollis*; it is only 10 mm. in diameter, with primary spines about

20 mm. long ; the collar is distinctly oblique ; the primaries are more as in *C. floridanus* than in *C. elegans*, as there is no banding except at the tip, but they are more greenish than in *C. floridanus*.

2. *Coelopleurus floridanus*.

A. Agassiz, 1872. Rev. Ech., pt. 1, p. 102. 1883, Mem. M.C.Z., 10, No. 1, pls. VII and VIII.

Primaries more or less bright red ; collar extends farther on abactinal ridge than on sides of spine.

1 young specimen from off Montserrat, 88 fms. (*Blake*).

3. *Coelopleurus interruptus*.

Coelopleurus floridanus var. *interrupta* Döderlein, 1910. Denkschr. Ges. Jena, 16, p. 257.

Coelopleurus interruptus H. L. Clark, 1923. Ann. S. Afric. Mus. 13, p. 379, pl. XXI, fig. 3.

Similar to *C. floridanus*, but primaries stouter ; red colour, more purple ; interambulacral areas brown with 9 or 10 transverse irregular bars of violet, and with a white stripe on each side.

1 specimen from 'Cape of Good Hope', off Cape Morgan, 77 fms. Labelled *Diadema saxatile*.

This specimen is young (10 mm. in diameter) ; it is in good condition. Bell named it *Diadema saxatile*, and under that name it is recorded in his report on the Echinoderma of South Africa (1904, Marine Inv. S. Afr., 3, p. 168).

4. *Coelopleurus longicollis*.

A. Agassiz and Clark, 1908. Mem. M.C.Z., 34, pp. 82, 83, 89.

A. Agassiz, 1881. *Challenger* Ech., pl. V, fig. 1, and pl. VI, figs. 22 a-c.

Primaries more or less uniformly whitish ; collar one-fifth of spine length, or more.

3 specimens from the *Challenger* collection ; St. 201, Philippine Islands, Basilan Strait, 82-102 fms., stones and gravel. Labelled *Coelopleurus maillardi*.

In the *Challenger* Report Agassiz referred all the specimens of *Coelopleurus* collected to the little-known *C. maillardi*, described by Michelin from Mauritius. Later he realized there were two quite distinct species in the *Challenger* collection, and that probably neither was *C. maillardi*. This led to the description first of *C. maculatus* (= *elegans*, vide supra) and then of *C. longicollis*, of which the present specimens are virtually paratypes. The largest is 40 mm. in diameter, with primary spines 80 mm. long.

Suborder 3. *CAMARODONTA*, Jackson.

Teeth keeled ; epiphyses of lantern wide, meeting in suture over foramen magnum ; primary tubercles imperforate.

Family 1. TEMNOPLEURIDAE, Desor.

Ambulacral plates compound, with 3 elements ; pits or sculpturing on coronal plates dorsally ; ocular plates usually all exsert.

This large and interesting family contains the smallest of the regular Echinoidea, and many of the most brilliantly coloured ; it is represented in the Museum by more than 600 specimens of 38 species. Most of this material has been studied by Dr. Mortensen, and his labels and his published notes on many of the more difficult genera and species have been of inestimable value in the preparation of this catalogue.

The family may be divided into two sections or sub-families, one of which (Trigonocidarinae) contains mostly deep-water forms, characterized by sculptured tests, usually of small size (under 20 mm. in diameter), while the other (Temnopleurinae) contains littoral species (sometimes found in water of considerable depth), whose tests are not sculptured and are of moderate or large size, as a rule. Specimens of the Trigonocidarinae are naturally less common in collections than those of the Temnopleurinae ; in the present collection there are fewer than 30 of the first group to more than 600 of the second. This scantiness of material of the Trigonocidarinae makes the characters and limits of genera and species uncertain, and accounts for most of the disagreements between recent writers. On the other hand, abundance of material of some of the littoral Temnopleurids has led to an increasing appreciation of their variability and diversity, and generic and specific lines have been drawn with a fair approximation to their natural limits. In the very characteristic Australian genus *Amblypneustes*, however, specific lines are still very hazy, and although Mortensen, Döderlein and myself have each essayed to make an artificial key, we are not yet in agreement, and I therefore make a new attempt in this catalogue to designate the natural species. But the work should really be done by an Australian zoologist who can study the living animals under natural conditions, and can work out the growth changes and the colour relations of large series of specimens.

1. TRIGONOCIDARIS.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 263.

Type, *Trigonocidaris albida* A. Agassiz, 1869. Bull. M.C.Z. 1, p. 263.

Buccal membrane fully plated : sculpturing of test evident ; madreporic genital with at least 10-15 pores.

1. *Trigonocidaris albida*.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 263. 1872, Rev. Ech., pt. 1, pl. IV, figs. 1-7.

Test low, pure white ; spines white, save for red rings on some near mouth.

3 specimens, of which 2 are without locality, and 1 is from off Havana, 242 fms. (*Blake*).

2. HYPsieCHINUS.

Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 81.

Type, *Hypsiechinus coronatus* Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 86.

Buccal membrane plated ; sculpturing of test slight ; madreporic genital with only 2 or 3 large pores.

1. *Hypsiechinus coronatus*.

Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 86, pl. VII, figs. 1-20.

Very small ; test low ; abactinal system large, more or less elevated.

2 specimens from *Ingolf* St. 78, south-west from Iceland, 799 fms. (*Mortensen*).

These are cotypes of this curious little species.

3. GENOCIDARIS.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 262.

Type, *Genocidaris maculata* A. Agassiz, 1869. Bull. M.C.Z., 1, p. 262.

Buccal membrane naked, at least outside the circle of large buccal plates. Periproct more than half covered by a single plate ; test without pits.

1. *Genocidaris maculata*.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 262. 1873, Rev. Ech., pt. 1, pl. VIII, figs. 1-18 (as *Temmechinus maculatus*).

Buccal feet 10, 1 to each plate ; these plates large, forming a nearly closed ring around mouth.

16 specimens, of which 5 are bare tests. Localities represented are : *Blake* St. 32, Gulf of Mexico, 95 fms. ; *Albatross* St. 2,596,

off Cape Hatteras, 49 fms. ; *Challenger* St. 75, Azores Islands, 50–90 fms. ; Mediterranean. The *Challenger* specimens were labelled *Sphaerechinus granularis*.

The 2 bare tests from the Mediterranean were identified by Mortensen. The *Albatross* specimen is in poor condition and is only 5 mm. in diameter. The *Blake* specimen is a very good one, but neither it nor the station are listed in the *Blake* Report, although there are 7 specimens in the Museum of Comparative Zoölogy from the same station. The *Challenger* specimens from the Azores are a very interesting lot. There are 12 of them, ranging from 4.5 to 11 mm. in diameter ; 3 are bare. The largest has several parasitic gastropods attached to the abactinal surface. The colour is variegated, green and white, but the primary spines are banded, in the larger specimens with reddish. One specimen, 9.5 mm. in diameter, has both test and pedicellariae distinctly red. Apparently the reddish shades misled Agassiz into thinking these were very young '*Sphaerechinus granularis*'. Hence they are listed under that species and *Genocidaris* (or *Temnechinus*, as Agassiz termed the genus) is not included in the *Challenger* Report at all.

4. ORECHINUS.

Döderlein, 1905. Zool. Anz., 28, p. 622.

Type, *Trigonocidaris monolini* A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 203.

Periproctal plates few, large, more or less glassy ; few plates proximal to buccal ring ; sculpturing on test quite distinct.

1. *Orechinus monolini*.

Trigonocidaris monolini A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 203. 1881, *Challenger* Ech., pl. VI a, figs. 8–10.

Orechinus monolini Döderlein, 1905. Zool. Anz., 28, p. 622.

Form of test diverse ; colour more or less white, sometimes strongly tinged with brown.

1 specimen from *Challenger* St. 170, near the Kermadec Islands, 520 fms., rocks.

This specimen, 8 mm. in diameter, is the holotype, and the only individual secured by the *Challenger*. The species has since been found to be common in the East Indies and at the Hawaiian Islands.

5. PRIONECHINUS.

A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 202.

Type, *Prionechinus sagittiger* A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 202.

Periproctal plates numerous and not glassy ; peristomal

membrane with few plates; test sculpturing usually very evident.

1. *Prionechinus agassizii*.

Wood-Mason and Alcock, 1891. Ann. Mag. Nat. Hist. (6), 8, p. 441. (No figures yet published.)

One or more of the anal plates distinctly larger than the rest; all buccal plates with tube-feet; genital pores at distal tips of plates; buccal plates large, close together; genital plates little sculptured.

1 specimen from *Challenger* St. 219, near the Admiralty Islands, 150 fms., mud, labelled *Echinus elegans*.

Agassiz listed this specimen from the Admiralty Islands as the European *Echinus elegans* without comment. It has a superficial resemblance to specimens of *E. elegans* of the same size, but, when examined with a lens, the test is seen to be sculptured and the pedicellariae to be obviously different from those of *E. elegans*. Mortensen examined this specimen and wrote of it (1903, *Ingolf* Ech., pt. 1, p. 145): 'There is an unpaired lateral tooth on the globiferous pedicellariae, and according to my observations by the short examination during my stay at the British Museum, I feel inclined to think that it is nearly related to *Arbacia forbesiana*; at all events it is a sure fact that it has nothing to do with *E. elegans*, and upon the whole does not belong to the family Echinidae.' My own study of the specimen confirms Mortensen's view, and I have accordingly placed it in *Prionechinus*, the genus in which I place *Arbacia forbesiana*.

For the present the specimen may be listed as *P. agassizii*. The original description of *P. agassizii* is inadequate, particularly in view of this specimen, because it makes no mention of colour. The types were not quite 14 mm. in diameter (unusually large for the genus), and the number of ambulacral and interambulacral plates in a column were equal. The present specimen is 16.5 mm. in diameter and 10 mm. high, and has 14 interambulacral and 19 ambulacral plates in a column; this increase in number of the ambulacral plates may be due to its greater age and size. The colour is bright red, with the poriferous areas pale yellow; spines, orange-red with light tips; all the plates of the buccal membrane pure white. The actinostome is 7 mm. across. No tridentate pedicellariae were found, but ophicephalous and globiferous are not rare; the valves of the globiferous are very much like those of the same pedicellariae in *Pseudochinus huttoni* as figured by Mortensen (1921, Vid. Medd., 73, pl. VII, figs. 12, 13), not unlike those of other species of *Prionechinus*.

2. *Prionechinus forbesianus*.

Cottaldia forbesiana A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 203. 1881, *Challenger* Ech., pl. VI a, figs. 15-17.

Prionechinus forbesianus de Meijere, 1904. *Siboga* Ech., p. 71.

Buccal plates large, in contact, each with a tube-foot; primary spines orange-red basally but white distally.

1 specimen from *Challenger* St. 173, near the Fiji Islands, 310-315 fms.

This is the holotype of the species. It is 16 mm. in diameter and 8 mm. high, and is probably adult, if not full grown. The actinal side is pure white, but the abactinal surface and the basal half of each spine is light orange-red, in rather striking contrast to the white tips. The species is apparently very near *P. ruber*, but the tuberculation of the test is much coarser.

3. *Prionechinus sagittiger*.

A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 202. 1881, *Challenger* Ech., pl. VI a, figs. 11-14.

Test more or less depressed; anal plates rather numerous; some (usually 5) of the buccal plates lack tube-feet.

2 specimens from the *Challenger* collection; from St. 207, Philippine Islands, 700 fms., mud, and from St. 218, between New Guinea and the Admiralty Islands, 1,070 fms., globigerina ooze.

These are the type specimens, and as Mortensen has stated (1903, *Ingolf* Ech., pt. I, p. 82) they are not of the same species and perhaps are not even congeneric. Furthermore, in the *Challenger* Report another specimen is mentioned, from St. 164 (off New South Wales, 950 fms.), and this individual is in the collection of the Museum of Comparative Zoölogy. I have therefore now had the opportunity to examine the material from each *Challenger* station, and I confess I am no nearer the correct placing of the different specimens than I was before I saw them. Mortensen is very sure that the specimen from St. 207 is not a *Prionechinus*, but he gives no reason for this. He even adds—'The spines are of the same structure as in *Prionechinus*.' Naturally, I examined the specimen with special care, and I was interested to find that there are apparently but*5 buccal feet, one to each pair of plates. Moreover, I could find no reason for not allowing the specimen to remain in *Prionechinus*, though I am far from asserting that it unquestionably belongs there. The truth is that the specimen is too small and in too poor condition to permit any certainty as to its identity.

The specimen from St. 218 is only 5 mm. in diameter and about 2 mm. high. It is brown and has no 'silvery lustre' whatever. This is puzzling, for Agassiz says the specimen

figured is 7 mm. in diameter, and Mortensen speaks of 'a very well preserved specimen' from which he thinks Agassiz's figure was made. Possibly there were 2 specimens from St. 218, of which the larger is now missing. We may consider this specimen as the type of the species, but we can have nothing but the vaguest ideas as to the real species characters until more and better material is secured. Now that I have seen this type, I am dubious as to whether the little sea-urchins collected by the *Siboga* and referred by de Meijere to *P. sagittiger* belong to this species.

6. OPECHINUS.

Desor, 1855. Syn. Ech. Foss., p. 107.

Type, *Temnopleurus costatus* d'Archiac and Haime, 1853. Anim. foss. de l'Inde, p. 204.

Sculpturing of test consists of 4-6 pits on each interambulacral horizontal suture at ambitus.

1. *Opechinus spectabilis*.

Mortensen, 1904. Dansk. Selsk. Skr. (7), 1, p. 94, pl. I, fig. 15.

No distinct suranal plate; 6 pits on each horizontal suture in interambulacra at ambitus.

1 specimen from *Challenger* St. 192, near the Kei Islands, 129 fms., mud.

This is the holotype.

7. TEMNOPLEURUS.

Agassiz, 1841. Mon. Ech., Anat. Echinus, p. vii.

Type, *Cidaris toreumatica* Leske, 1778. Add. ad Klein, p. 155.

Test with pits; primary tubercles crenulate; coronal plates at ambitus with 1-3 (rarely 4) primary tubercles; seldom over 50 mm. in diameter.

1. *Temnopleurus hardwickii*.

Toreumatica hardwickii Gray, 1855. Proc. Zool. Soc. London, p. 39.

Temnopleurus hardwickii A. Agassiz, 1872. Rev. Ech., pt. 1, p. 166. 1873, Rev. Ech., pt. 3, pl. VIII a, figs. 1-3.

Poriferous areas narrow; pore-pairs small; primary spines not banded, very dark, almost black at base.

9 specimens from the following stations: Japan, Sendai Bay, 9 fms.; Japan, off Yokohama, 6-14 fms. (*Challenger*); Japan, 35° 26' N., 139° 40' E., 4 fms.

Of the *Challenger* specimens, one is quite young, but 5 range

from 24 to 44 mm. in diameter. None calls for any comment, but it is interesting to note the very restricted range of this species, known as yet only from the eastern and south-eastern coasts of Japan.

2. *Temnopleurus reevesii*.

Toreumatica reevesii Gray, 1855. Proc. Zool. Soc. London, p. 39.
Temnopleurus reevesii Mortensen, 1904. Dansk. Selsk. Skr. (7), 1, p. 62. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. VIII a, figs. 6 and 7 (as *T. reymaudi*).

Primary spines not banded, not very dark at base ; ocular I usually nearly or quite insert.

32 specimens, of which 2 are bare. Localities represented are : Korea, 40 fms. ; China ; Chusan Archipelago ; Japan, Uraga Channel, 50 fms. ; Macclesfield Bank, 5 fms. ; *Challenger* St. 192, near Kei Islands, 129 fms., mud ; *Challenger* St. 219, near Admiralty Islands, 150 fms., mud ; *Challenger* St. 166, near New Zealand, 275 fms., globigerina ooze. The specimens from Chusan were labelled *T. toreumaticus*, and the one from Uraga Channel was labelled *Salenia*. Those from China and Korea were named *T. reymaudi*.

The best specimens of this rather delicate species are those from Macclesfield Bank, which are really superb, but the 14 specimens from Chusan are a fine series. Five from *Challenger* St. 192 are only 7-9 mm. in diameter, but they seem to be *T. reevesii*. The single specimen from St. 219, 11 mm. in diameter, also seems to be correctly determined, but the one from St. 166 is only 4 mm. through, and is much too young to permit any accurate determination. Mortensen (1904, Dansk. Selsk. Skr. (7), 1, p. 64) considers that the specimens from Sts. 192 and 219 are not *T. reevesii*, but that the one from St. 166 may be. His conclusions strengthen my belief that accurate determination of isolated young Temnopleurids is seldom possible.

The two specimens from China are bare tests, the types of Gray's *Toreumatica reevesii* ; one is 21 mm. in diameter ; in it no ocular plate reaches the periproct ; the other is 35 mm. in diameter, but the abactinal system is damaged, and I am not able to say whether an ocular was insert or not. Yet Mortensen (*l. c.*, p. 63) says of these very specimens that one ocular plate reaches the periproct !

The 2 specimens from Korea are very young, only 8-9 mm. in diameter, yet in one of them ocular I is insert. In both the abactinal system is remarkably smooth and made up of very thin plates. The specimen from Uraga Channel is also very young, 9 mm. in diameter ; it is bleached ; its identity is open to question.

3. *Temnopleurus toreumaticus*.

Cidaris toreumatica Leske, 1778. Add. ad Klein, p. 155.

Temnopleurus toreumaticus L. Agassiz, 1841. Mon. Ech., Anat. Echinus, p. vii. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. VIII a, figs. 4 and 5.

74 specimens, of which 27 are bare tests and 19 are without locality labels. Localities represented are: Korea; Japan, 24 fms.; Japan, Kobe (*Challenger*); off Yokohama (*Challenger*); Japan, 35° 26' N., 139° 40' E., 4 fms.; China, Amoy; Singapore; Malacca; Penang; Penang, Polo; Philippines, Negros; St. 203, Philippine Islands, 12-20 fms., mud (*Challenger*); Arafura Sea; Australia; Queensland, Port Curtis, 11 fms., sand and shells (*Alert*); Queensland, Port Denison, 3-4 fms., sand (*Alert*); Burma, Gulf of Martaban; Ceylon; India, Tuticorin; Gulf of Cutch; Karachi.

This is a very diversified series, ranging from 4.5 mm. to 58 mm. in diameter. The smallest, from the Arafura Sea, is labelled *T. hardwickii*; it is much too young to show specific characters, but I think it is *T. toreumaticus*. The specimen from Korea is only 9 mm. in diameter, but the primary tubercles are crenulated as in an adult. There are 3 specimens from Japan, 24 fms., labelled *T. granulosus* Gray; the brown colour and the numerous abactinal tubercles make them seem different from *T. toreumaticus*. Of the bare specimens without locality label, one is said to be the type of *T. granulosus* Gray; I fully agree with Mortensen that *T. granulosus* cannot be distinguished in any satisfactory way.

The 3 specimens from Negros are 25-28 mm. in diameter: they have very slender primary spines, 20-25 mm. long. Two similar specimens, without locality, are probably from the same lot. All are notable because only the spines near the mouth are banded and these not conspicuously; the superficial appearance is thus a little like *T. reeresii*. The specimen from Port Denison is a young one, the only true *T. toreumaticus* in the *Alert* specimens from that port. (See Mortensen, 1904, Dansk. Selsk. Skr. (7), 1, No. 1, p. 60.)

There is great diversity of colour shown in this series of *T. toreumaticus*, and it is not unlikely that several colour varieties may be recognized. At one extreme are two large specimens from Japan, very dark, both test and spines being coloured with deep olive and deep blackish-brown. At the other extreme is the debatable specimen from Queensland (Port Curtis, not Port Denison) to which Bell refers in the *Alert* Report (p. 119) as having 'all the spines which are preserved on it perfectly white, without any bands whatever'. Mortensen (1904, *l. c.*) asserts that this specimen 'is not *T. toreumaticus*; its globiferous pedicellariae have no lateral teeth'. The specimen is 18 mm. in diameter by 9 mm. high; the test, like the spines, is for the most part pure white, but on

the abaectinal system there is a green tinge. I am unable to find characters to separate the specimen from *T. toreumaticus*, and I think it may be an albino; the reduction of the lateral teeth on the valves of the globiferous pedicellariae does not seem important. In the jar with this example is another, somewhat larger, the colours of which are green and rose; the abaectinal system is particularly pretty with its mingling of green and rose; the primaries are whitish with green-brown bands. This specimen seems to be a light coloured *T. toreumaticus*, intermediate between a typical specimen and the puzzling white one.

Specimens from Ceylon and from Tuticorin are very light coloured, but none of them can be termed var. *perezi*. The *Challenger* specimens from Kobe are also light coloured; they are labelled *T. hardwickii*, and are so listed in the *Challenger* Report; they are unquestionably *T. toreumaticus*, as Mortensen (*l. c.*, p. 62) has already stated. One of the specimens from Singapore is also very light coloured, nearly white, with some red-purple, and the primaries banded with the same colour. This specimen is only 11 mm. in diameter, but with it is another, 35 mm. through, which is quite brown. It is probable that the light and often bright coloration may be a youthful character, which generally disappears early in life, but is more or less frequently retained after adult size is reached.

The shape of the test in *T. toreumaticus* shows great diversity. As a rule the height is about half the diameter and the abaectinal region is slightly flattened, but sometimes the flattening is very marked; one bare test 47 mm. in diameter is only 22 mm. high. On the other hand, the abaectinal system is frequently elevated, and often the test tends to become quite conical; a specimen 43 mm. in diameter is 26 mm. high, while an extreme example is a bare test 58 mm. in diameter and 42 mm. high.

3 a. *T. toreumaticus* var. *perezi*.

Temnopleurus perezi Koehler, 1906. Bull. Paris Mus., 11, p. 460.

Test and small spines nearly white; primary spines pale yellowish, banded with reddish-violet or reddish-brown.

6 specimens: 2 from India, Karachi, and 4 from Muscat.

This is a very pretty and very light-coloured form of *Temnopleurus* that, at first sight, looks quite different from *T. toreumaticus*, but there seem to be many connecting links, and I regard it as a colour variety. Possibly it is a subspecies characteristic of the north-west corner of the area occupied by *T. toreumaticus*. The specimens from Muscat are 20 mm. in diameter; their primary spines are 25 mm. long and are very slender.

8. SALMACIS.

Agassiz, 1841. Mon. Ech., Anat. Echinus, p. viii.

Type, *Salmacis bicolor* Agassiz, 1841. Mon. Ech., Anat. Echinus, p. viii.

Test high, or somewhat flattened, usually over 50 mm. in diameter when adult; tubercles crenulate; coronal plates at ambitus each with 4-9 primary tubercles.

1. *Salmacis belli*.

Salmacis sphaeroides var. *belli* Döderlein, 1903. Denkschr. Ges. Jena, 8, p. 718, pl. LXIV, figs. 1-1 c.

Salmacis belli Mortensen, 1904. Dansk. Selsk. Skr. (7), 1, p. 68.

Primary spines banded, more or less rose-red, green at base; gill cuts insignificant.

16 specimens from the following localities: North-western Australia, Holothuria Bank, 15-38 fms.; Banda Sea, Damma Island, 9-15 fms.; *Challenger* St. 188, west of Torres Strait, 28 fms., mud; *Challenger* St. 186, near Wednesday Island (Torres Strait), 8 fms., coral sand; Queensland, Port Molle, 12-20 fms., rock, coral (*Alert*). The specimens from Holothuria Bank were labelled *Salmacis sulcata*, or were unidentified; those from Damma Island were labelled *Salmacis globator*; the *Challenger* specimens were labelled *S. rarispina* (corrected to *S. belli* by Mortensen); the *Alert* specimens were named *S. bicolor* (corrected to *S. belli* by Mortensen).

Most of these specimens are young and some are very immature; those from Port Molle are fine. The Damma Island specimen is 40 × 26 mm., and has the test fawn-coloured, unusually dark for *T. belli*. A little specimen, 14 × 8 mm., from *Challenger* St. 186, has a similar colour. The specimen from Holothuria Bank, named *S. sulcata*, is in poor condition; the spines are very light, perhaps bleached, and there are very few abactinal tubercles; the smallest individual, from Holothuria Bank, measures 10 × 5 mm.

2. *Salmacis bicolor*.

Agassiz, 1841. Mon. Ech., Anat. Ech., p. viii. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. VIII a, figs. 11 and 12.

Primary spines more or less bright red, at least at base, banded; small spines bright red.

38 specimens, of which 5 are bare tests. Localities represented are: Philippine Islands, Zamboanga; Macclesfield Bank, 30-40 fms.; Singapore, 10 fms., sand; East Indies; Bondy Head; Ceylon; India, Tuticorin; India, Madras; India, Vizagapatam; Karachi; Mauritius; Madagascar; Madagascar, Belo Bay; British East Africa, Wasin Island, 10 fms. (*Crossland*); Zanzibar.

The specimens from Zanzibar and Zamboanga are particularly fine. That from Macclesfield Bank is the smallest, 7 mm.

in diameter, with spines 7 mm. long; it is labelled *Temnopleurus torcumaticus*. The largest specimen, 77×49 mm., is from Zamboanga. A bare test labelled Portugal (an error), and named *S. rarispina*, is 73 mm. in diameter and 53 mm. high. One from Ceylon is even higher, 47×38 mm., the height thus about 80 per cent. of the diameter. The specimens from Madagascar are really the most interesting of all, for they show a type of coloration which is very perplexing. The larger, 45 mm. in diameter, shows no red whatever, looking like a bright-coloured *S. sphaeroides*; there is much violet on the primary spines: the small spines are violet and reddish-brown, and the bases of the abactinal primaries are tinged with red; large globiferous pedicellariae are very abundant. The smaller specimen, from Belo Bay, is only 22 mm. in diameter, and although its general coloration is like that of the larger, the bases of the primary spines and the smaller spines are much redder. The pedicellariae show that these specimens are *S. bicolor*, but it would be very easy to mistake them for *S. sphaeroides*. Two from Madras are of interest, for one is a typical *S. bicolor*, but the other is almost as violet (or purple) and as free from red as are the Madagascar specimens.

3. *Salmacis dussumieri*.

Agassiz and Desor, 1846. Ann. Sci. Nat., 6, p. 359. Döderlein, 1903. Denkschr. Ges. Jena, 8, pl. LXIII, figs. 5 a-c.

Test low; only every other ambulacral plate in midzone has a primary tubercle near poriferous area; small spines not red at base.

22 specimens, of which 4 are bare and 2 are without locality label. Localities represented are: India, Tuticorin; Burma, Gulf of Martaban; Singapore; *Challenger* St. 212, near Zamboanga, 10-20 fms., sand; East Indian Ocean; Holothuria Bank, 32 fms.; *Challenger* St. 186, Torres Strait, 8 fms., coral sand; Queensland, Port Denison, 4 fms. (*Alert*); Port Molle, 14 fms. (*Alert*); Port Curtis, 5-11 fms. The *Alert* specimens were labelled *S. sulcata*.

There is great diversity of size and colour in this series, but on the whole the distinctive species characters are well shown. The specimens from Tuticorin are very dark, in striking contrast to the young specimens from Singapore, Holothuria Bank, and *Challenger* St. 186, which are white, with violet or violet and white primary spines. Two very flat specimens, 9 and 10 mm. in diameter, without locality, show the same pretty coloration; they are labelled *Temnopleurus torcumaticus*. The specimen from *Challenger* St. 212 is larger, and the general effect abactinally is dull flesh red and dirty white; the long primaries of the ambitus are pale greenish with reddish bases and dull purple bands. It seems probable that

young individuals are generally purple and white, and become dingier and darker as they mature, until the condition shown by the Tuticorin specimens is reached: no doubt the change is hastened or hindered by local conditions.

The specimens labelled 'East Indian Ocean' are small, bare tests, the types of *Toreumatia concava* Gray.

4. *Salmacis erythraxis*.

A. Agassiz and Clark, 1912. Mem. M.C.Z., 34, p. 315, pl. III, figs. 4-6.

2 specimens, 1 from Zanzibar, 5 fms. (*Crossland*), and 1 from Seychelles, 12 fms., coral (*Alert*).

The specimen from Zanzibar is a very fine one, 53 mm. in diameter and 25 mm. high. Mortensen identified it as *S. dussumieri*, but added a note that it might be a new variety. The colour is very dark, with the bases of the miliary spines in the midzone brilliant red. The Seychelles specimen is 7.5 mm. in diameter and 2.75 mm. high; the test is white; the primally spines abactinally are very dull greenish, whitish at base and tip, but in midzone they are bright violet, white at base and tip; all the small spines have the characteristic brilliant red bases. Mortensen had examined this specimen also, and his label reads—'*Salmacis* n. sp. or *S. dussumieri*??' A good series of specimens from the western Indian Ocean may demonstrate that *S. erythraxis* is only a colour variety of *S. dussumieri*. Agassiz and I (*l.c.*) confused the dark-coloured specimens of *S. dussumieri* from Tuticorin with this species, but they are quite distinct.

5. *Salmacis rubricincta* sp. nov. PLATE V, figs. 3, 4.

Test rather high, somewhat bluntly conical, 51 mm. in diameter and 31 mm. high. Coronal plates 25 or 26 in a column. Ambulacral plates 29 or 30 in each column. Abactinal system only 9 mm. across, the periproct just half of that. All oculars completely exsert. Periproct covered by a considerable number of plates, many of which carry secondary spines. There is a primary tubercle on each ambulacral plate. Actinostome 11 mm. across; gill cuts broad and shallow. Actinal primaries not noticeably widened at tip. Pedicellariae essentially like those of *S. bicolor*.

Colour of test, pale apple-green, tending to white, especially orally, and with white markings on both the ambulacra and interambulacra. Primary spines pure white with bright red rings; there is a ring near the tip and 1, 2 or 3 rings on the basal part of each spine. Small spines white, those on the abactinal system with bright red bases.

Indian Ocean, Saya de Malha, 40 fms. (*Gardiner*). 5 specimens, labelled *Salmacis bicolor*, pale variety.

This species is based on the coloration, which is so striking and so entirely unlike that of any other member of the genus. There are 5 specimens, of which the smallest is 40×23 mm. (the holotype is the largest), and they show no variation.

6. *Salmacis sphaeroides*.

Echinus sphaeroides Linné, 1758. Syst. Nat., ed. 10, p. 664.

Salmacis sphaeroides Lovén, 1887. Bih. Svensk. Vet.-Akad. Handl., 13 (4), No. 5, p. 69. Döderlein, 1903. Denkschr. Ges. Jena, 8, pl. LXIII, figs. 1-4 a.

Primary spines green, at least at base, not rose-red, abactinally conspicuously banded; gill cuts deep.

23 specimens, of which 4 are bare. Localities represented are: Gulf of Siam, Kosichang; Billiton; Singapore; Singapore, Siglap; Philippine Islands, Cebu; P.I., Cebu, Mactan Reef; P.I., Mindanao; Australia; East Australia; New Guinea, south-eastern coast, Hoods Lagoon; Queensland, Port Denison, 3-4 fms., sand (*Alert*); Solomon Islands, Ugi.

The specimens from Hoods Lagoon, Ugi, and Mactan Reef were labelled *S. sulcata*, while those from Australia, East Australia, and Singapore were named *S. globator*. The 5 little specimens from Port Denison were labelled *Temno-pleurus granulatus* Gray.

There is much colour diversity, but it does not seem to be the young ones that are lightest coloured. The five from Port Denison are very small but they are very dark and have much red on the spines. The adults from Billiton are very pale coloured, with little green, most in the smallest specimen and least in the largest, confined to the very bases of the spines and to the abactinal part of the test; the primary spines are white, especially actinally, more or less banded with red-purple. Three specimens from Singapore are remarkable for the light brown colour, with little green; few primary spines, above the ambitus, are banded, and the bands are few and dark. The specimens from Cebu and from Hoods Lagoon are fine and very dark coloured. The individual from East Australia is a bare test 100 mm. in diameter and 67 mm. high.

7. *Salmacis virgulata*.

Agassiz and Desor, 1846. Ann. Sci. Nat., 6, p. 359. Döderlein, 1903. Denkschr. Ges. Jena, 8, pl. LXII, figs. 2 and 2 a.

Primary spines not banded; colours diverse, base and tip often different; coronal plates separated from each other only by sutures, the edge of which may be slightly bevelled.

33 specimens, of which 9 are bare and 5 are without locality labels. Localities represented are: India, Tuticorin; Ceylon; Ceylon, Chevaal Paar (*Herdman*); Singapore, 5-10 fms.; Billiton; *Challenger* St. 186, Torres Strait, 8 fms., coral sand;

New South Wales, Port Jackson, Sow and Pigs Reef ; South Australia, Eden ; North-west Australia, $14^{\circ} 50' \text{ S.}$, $125^{\circ} 40' \text{ E.}$

The Torres Strait specimen was labelled *S. globator*, and the Herdman specimen from Ceylon, which is very young, was labelled '*Temnopleurus yg.*'

The 14 specimens from Tuticorin include a bare test, 66 by 43 mm. ; the others range from 20 to 50 mm. in diameter, and are greenish-white with the primary spines bright red-violet, more or less white tipped. The Port Jackson specimen appears bleached. The bare tests without locality labels show great diversity of form ; thus a specimen 41 mm. in diameter is less than 21 mm. high, but another 45 mm. in diameter is 38 mm. high and quite conical ; the largest is 76×54 mm. The specimen from north-western Australia is remarkable in that ocular I is insert ; the test is low, 25×12.5 mm., and the coloration is interesting ; above the ambitus all is white ; below, the test is white, but the primary spines are violet with white tips. This specimen suggests *S. dussumieri* so strongly that the possibility of its being a hybrid, *S. virgulata* $\times$ *S. dussumieri*, should not be ignored.

7 a. *S. virgulata* var. *alexandri*.

Salmacis alexandri Bell, 1884. *Alert* Report, p. 118. Döderlein, 1903. *Denkschr. Ges. Jena*, 8, pl. LXII, figs. 5-7 a.

Like *S. virgulata*, but coronal plates separated by deep horizontal furrows, the sides of which are more or less vertical.

36 specimens, of which 3 are bare and have no locality label. Localities represented are : North-eastern Holothuria Bank, 15-20 fms. ; Parry Shoal ; Torres Strait, Prince of Wales Channel, 5-7 fms. (*Alert*) ; Torres Strait, Thursday Island, 3-4 fms., sand ; Queensland, Port Denison, 3-4 fms., sand (*Alert*) ; New South Wales, Port Jackson. The specimens from Port Denison were labelled *Temnopleurus toreumaticus*.

About two-thirds of these specimens are from Port Jackson, and all are from Australian seas. One from Port Denison is very dark coloured (test dark purplish-fawn colour, primary spines dull reddish, pedicels very dark purplish) and the pits on the test are very deep and conspicuous, as in *Temnopleurus toreumaticus*. The 2 others, from Port Denison, are fine examples, typical *S. alexandri*, 35 mm. and 55 mm. in diameter. The Port Jackson examples range in diameter from 26 to 81 mm., and the relative height shows great diversity ; one specimen 81 mm. in diameter is 44 mm. high, but another also 81 mm. in diameter is 55 mm. high. The lowest specimen is 70×32 mm. ; it has a large abactinal system and a big periproct, but the oculars are all exsert as usual. The ambitus is normally a circle, but occasionally it is a very distinct pentagon with rounded angles. The diversity of colour is even more remarkable than the diversity of form ; one specimen

is bright yellow-green; another is green with the primaries brownish basally; a third is green with primaries chestnut-brown, lighter distally and white at tips; several are red-violet, one is dull rose; the very low one has the abactinal spines pale brownish or almost white, the pedicels brown, and the actinal spines dull red-violet with white tips; still another has the distal half of the spines, especially below ambitus, bright violet.

It is very doubtful whether this form is worthy of varietal rank, but it is retained because it is not yet known from the northern part of the area occupied by *S. virgulata*. Typical *S. virgulata* also occur in Australia, but the tendency is towards the deep, distinct grooves of *S. alexandri*. It may be that the variety is associated with definite environmental conditions.

9. TEMNOTREMA.

A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 358.

Type, *Temnotrema sculpta* A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 358.

Size small, rarely more than 20 mm. in diameter; primary tubercles not crenulated; every ambulacral plate with a primary tubercle close beside the poriferous area; pore-pairs in a narrow vertical series; coronal plates with deep, conspicuous, usually oblong pits at the sutural angles and on the horizontal sutures.

1. *Temnotrema decorum*.

Döderlein, 1914. Fauna Südwest-Austral.: Echinoidea, p. 459. 1903, Denkschr. Ges. Jena, 8, pl. LXI, figs. 1-2 b (as *Pleurechinus bothryoides*). (= *Pleurechinus bothryoides* L. Agassiz et Desor, 1846, *et auct. post.*, non *Pleurechinus bothryoides* L. Agassiz, 1841.)

Test high, dark; anus central; primary spines with 2-4 bright red bands.

19 specimens. The following localities are represented: North-eastern Holothuria Bank, 15-20 fms.; Holothuria Bank, 24 fms.; North-west Australia, Baudin Island; Torres Strait, Prince of Wales Channel, 7-9 fms. (*Alert*); Thursday Island, 3-4 fms., sand (*Alert*); St. 186, Torres Strait, 8 fms., coral sand (*Challenger*). The specimens from North-eastern Holothuria Bank were labelled '*Temnopleurus* young'.

This is a noteworthy series of a rare little sea-urchin, a species unrepresented in the Museum of Comparative Zoölogy. The largest specimen is 20.5 mm. in diameter by 12 mm. high; another is 20 by 13 mm.; the highest is 16 by 11 and the lowest 14 by 8. The coloration shows some diversity in shade, but not much in pattern. The bright red

rings on the spines are very distinctive. One of the *Alert* specimens from Thursday Island has very little red on the spines, but the others are more brilliant. The ground colour varies from light green to a dark brownish-olive; most of the specimens are rather dark, but 3 of those from Holothuria Bank and the 2 from *Challenger* St. 186 are distinctly light green. The very large pits give the test a striking appearance, which, combined with the handsome colour, makes the recognition of the species easy.

2. *Temnotrema maculatum*.

Pleurechinus maculatus Mortensen, 1904. Dansk. Selsk. Skr. (7), 1, p. 89; pl. I, figs. 4 and 14.

Temnotrema maculata H. L. Clark, 1912. Mem. M.C.Z., 34, p. 318.

Buccal plates 10: suranal distinct: pits large, longer than distance between 2: test rather high: no green in coloration; genital plates often crossed by a transverse line.

14 specimens from Macclesfield Bank, 32-46 fms.; Borneo; off Northern Australia, Evans Bank, 12-15 fms. The specimens from Evans Bank and 2 of those from Macclesfield Bank were labelled simply '*Temnopleurus*', but the others were labelled *Temnopleurus bothryoides*.

Mortensen was doubtful whether this should be considered a distinct species or a variety of *T. bothryoides*. The main features of the test are like those of *T. bothryoides*, but the coloration is different. The specimens from Macclesfield Bank, and the one from Borneo, form a good series 8.5-19 mm. in diameter with the height of the test ranging from less than 60 per cent. to more than 75 per cent. of the diameter. The small specimens tend to have the primary spines more or less banded with reddish or orange, but on the adults the spines are not at all banded. The largest specimen is very pretty, with white test and red markings. The identity of the specimen from Evans Bank is uncertain; it is only 9 x 6 mm. and shows no line across the genital plates, but the secondary tubercles are in a horizontal line on the plates of the midzone. The test is a rather dark purplish-red above the ambitus, the pedicels are white, and the spines are reddish or white with 1-3 faint bands of reddish; around the peristome the colour is pale yellow.

3. *Temnotrema pallescens* sp. nov. PLATE VII, figs. 5, 6.

Test 14 mm. in diameter and 10 mm. high, with huge pits in both ambulacra and interambulacra as in *T. decorum*. Coronal plates 15 in each column, with the ambulacral plates a little more numerous (19-20). Abactinal system 4 mm. in diameter, of which the periproct is not quite one-half. Genital plates high, but somewhat oblong, and clearly wider than

high ; a large pore on the extreme distal margin ; a series of 3 secondary tubercles on the inner margin. Ocular plates small, decidedly exsert, as usual in the genus, with a conspicuous pit at the innermost angle, and usually 2 secondary tubercles, one on either side. Periproct with a distinct but small suranal plate, carrying one small spine. Actinostome 5 mm. across with 5 pairs of very small buccal plates, each with a tube-foot. Primary spines with a blunt or slightly swollen tip ; most of the spines are wanting from the abactinal surface and midzone. Pedicellariae few and hard to find ; those that were found were not essentially different from those of *T. maculatum*.

Colour of test green with a purplish cast : the pits are quite green, sometimes yellowish, sometimes dark ; areas between pits purplish. Spines pale lavender, the primaries whitish at tip, often with one or two very indistinct dusky bands.

Billiton, 1 specimen.

This species is obviously closely related to both *T. decorum* and *T. maculatum*. The colour and form of the test is like *T. decorum*, but the difference in the spines is too great to be ignored ; the entire absence of red is very striking. On the other hand, the abactinal system, especially the genital plates and the relatively small ocular plates, cannot be reconciled with what is found in *T. maculatum*, and the coloration too is very different.

4. *Temnotrema scillae*.

Temnechinus scillae Mazetti, 1894. Mem. R. Acad. Sci. Modena (2), 10, p. 213.

Temnotrema scillae H. L. Clark, 1912. Mem. M.C.Z., 34, p. 318. Mortensen, 1904. Dansk. Selsk. Skr. (7), 1, pl. 1, figs. 9, 10, 17 and 18 (as *Pleurechinus scillae*).

Similar to *T. maculatum* but test not so high, and suranal plate very large, covering half or more of periproct.

20 specimens, of which 2 are bare and 1 is without locality label. Localities represented are : Suez ; Muscat ; British East Africa, Wasin Island (*Crossland*) ; Holothuria Bank, 15 fms., New Britain, 35 fms. The specimens from Wasin are labelled '*Temnopleurus yg.*', while those from New Britain are labelled *Pleurechinus reticulatus*.

The 2 specimens from New Britain are small, bare, and in poor condition, but I agree with Mortensen (1904, *l. c.*, p. 86) that they are of the same species as the dozen from Muscat. The specimen from Wasin is a fine example, but those from Holothuria Bank are very small and their identity is less certain. The 2 specimens from Suez and one from an unknown locality are adults, about 9 mm. in diameter, and although they are typical in other ways, the spines are scarcely

thorny, so little so indeed that careful examination with a lens is necessary to make it visible. This species is very near *T. siamense*, and I am not satisfied that the two are distinct.

5. *Temnotrema sculptum*.

A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 358.
Mortensen, 1904. Dansk. Selsk. Skr. (7), 1, pl. 1, figs. 5, 6, 8 and 19 (as *Pleurechinus variegatus*).

Like *T. maculatum* but pits small; ambulacral plates equal interambulacral in height and number; test variegated grey and whitish.

10 specimens, 5 from Japan and 5 from Korea. The localities are: Korean coast; Korea, 34° 13' N., 136° 13' E., 48 fms.; Japan, Kobe, 8-50 fms. (*Challenger*).

The 5 *Challenger* specimens from Kobe are every fine, 7.5-15 mm. in diameter. They were listed in the *Challenger* Report as *Pleurechinus bothryoides*. The Kobe specimens have the pits on the test small and shallow, and their colour shows no little diversity. The test is usually variegated purplish, greenish (of an olive shade usually) and white or whitish; but it may be light olive with little variegation. The primary spines are reddish basally (sometimes quite bright, sometimes very pale), becoming light or even whitish at the tip. Rarely the spines are pale greenish and brownish, and there may be a darker band around the distal part. The number of ambulacral plates is the same as that of the interambulacral, quite an unusual condition.

6. *Temnotrema siamense*.

Pleurechinus siamensis Mortensen, 1904. Dansk. Selsk. Skr. (7), 1, p. 79, pl. I, figs. 2, 7, 11 and 20.

Temnotrema siamensis H. L. Clark, 1912. Mem. M.C.Z., 34, p. 318.

Very similar to *T. scillae* but spines smooth, primaries often swollen at tip.

28 specimens, of which 2 have no locality label. Localities represented are: Seychelles, 12 fms. (*Alert*); Macclesfield Bank, 30-50 fms.; Holothuria Bank, 15-36 fms. Of the specimens from Macclesfield Bank, 1 was labelled *Salmacis rufa* and 10 were named *Temnopleurus bothryoides*.

The 2 specimens without locality are not perfectly typical, and might perhaps be as correctly referred to *T. scillae*; the primaries are very little enlarged at tip and the smaller spines are not perfectly smooth; all the spines are reddish at base and are not banded.

The specimens from the Seychelles and from Holothuria Bank were identified by Mortensen. One from Macclesfield Bank is remarkable for the presence of 2 suranal plates and

for having the primary spines banded with reddish, not greenish.

6 a. *T. siamense* var. *pulchella*.

Pleurechinus siamensis var. *pulchellus* Mortensen, 1904. Dansk. Selsk. Skr. (7), 1, p. 82. (No figures published.)

Like *T. siamense*, but colour of test and spines is bright red.

2 specimens from Marie Louise Island, Amirante Group, 17 fms., coral (*Alert*).

These are apparently type-specimens.

10. MESPILIA.

Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 357.

Type, *Echinus globulus* Linné, 1758. Syst. Nat., ed. 10, p. 664.

Coronal plates with very small pits; median abactinal interambulacral areas more or less bare; pore-pairs distinctly biserial.

1. *Mespilia globulus*.

Echinus globulus Linné, 1758. Syst. Nat., ed. 10, p. 664.

Mespilia globulus Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 358. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. VIII a, figs. 13 and 14.

27 specimens, of which 14 are bare and 8 are without locality. Localities represented are: Korean Strait, 24 fms.; Japan, Misaki; Macclesfield Bank, 13-34 fms.; Philippine Islands; P.I., Zamboanga; Celebes, Badjona; New Guinea; Loyalty Islands; Samoa, coast of Savaii.

The Samoan specimens, 42×26 mm., are the most typical examples of this beautiful and well-known species. Three from Korea are young, and were labelled *Salmacis sulcata*.

1 a. *M. globulus* var. *albida* var. nov.

Test 30 mm. in diameter, and 18 mm. high, perfectly bare, without spines or pedicellariae. Abactinal system missing. Arrangement of plates, tubercles, and pores as in *M. globulus*. Ground colour of test light olive-green, with no trace of red; median ambulacral areas above ambitus, more or less of median interambulacral areas, and nearly all tubercles, white with a slightly greenish tinge.

Without locality label, 1 specimen.

This is a very handsome bare test. I have never seen a specimen of *M. globulus* with any white on the test. The variety *pellocrica* (H. L. Clark, 1912, Mem. M.C.Z., 34, p. 322) lacks red altogether and has some white on the spines; but

re-examination of the type-material of *M. pellocrica* convinces me that this perplexing specimen is no nearer that variety than it is to typical *M. globulus*.

1 b. *M. globulus* var. *whitmaei*.

Mespilia whitmaei Bell, 1881. Proc. Zool. Soc., p. 433. (No figure published.)

Like *M. globulus* but abactinal interambulaera and median areas of ambulaera densely covered with small tubercles.

1 specimen from Samoa.

Mortensen (1904, Dansk. Selsk. Skr. (7), 1, p. 98) asserts that *M. whitmaei* must be withdrawn as a synonym only of *M. globulus*, but examination of the holotype has left me in doubt whether it is not a good species. It is certainly a very easily recognizable variety, for I have not seen another specimen of *Mespilia* comparable in the tuberculation of the abactinal part of the test. Other specimens from Samoa are obviously different, and the fact that only one specimen of *M. whitmaei* has as yet been found makes it probable that it is merely an extreme individual variant. Possibly the specimen is not from Samoa but from some less well-known area.

11. MICROCYPHUS.

Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 358.

Type, *Microcyphus maculatus* Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 358.

Coronal plates few, with small pits or none; actinal interambulacral plates not noticeably different from abactinal; bare interambulacral space extended more or less conspicuously along the horizontal sutures.

1. *Microcyphus annulatus*.

Mortensen, 1904. Dansk. Selsk. Skr. (7), 1, No. 1, p. 101. (No figure published.)

Test high; interambulacral areas broad, light coloured; poriferous areas narrow; primary spines with a broad band of red.

13 specimens from the following places; Victoria, Port Philip Heads; *Challenger* St. 161, off entrance to Port Philip, 38 fms., sand; *Challenger* St. 162, Bass Strait, off East Monocoeur Island, 38-40 fms., sand. All the *Challenger* specimens were listed in the Report as *Microcyphus zigzag*.

All these are fine or even superb examples of this very distinct species. The 7 specimens from St. 161 range from 5×3.75 mm. to 16.5×12 ; in 3 only a very few of the primary spines show the red bands; the ambitus is circular in all, so that apparently the original specimen, which Mortensen (*l.c.*)

says was 14.8 mm. long by 12.8 mm. wide, is not now in this lot. The 5 specimens from St. 162 range from 16 × 12 to 19 × 17 mm. They are noteworthy for their size, and for having the bare interambulacral areas pale fawn colour.

2. *Microcyphus compsus*.

H. L. Clark, 1912. Mem. M.C.Z., 34, p. 322. (No figure published.)

Bare interambulacral spaces narrow, rose-red; primary spines pale reddish, not banded.

2 specimens, 1 from Port Philip, labelled *M. elegans* Mort., and 1 from Port Philip Heads.

These are the types of *M. elegans* Mortensen (1904, Dansk. Selsk. Skr. (7), 1, p. 100). *M. elegans* being preoccupied, it was necessary to substitute the name *M. compsus*.

3. *Microcyphus maculatus*.

Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 358. A. Agassiz, 1873. Rev. Ecl., pt. 3, pl. VIII a, figs. 8–10.

Poriferous areas broad, with small tubercles present in them; coronal plates few; spines green, sometimes with light tips. This is the largest species in the genus.

17 specimens, of which 8 are bare tests and 1 is without a locality label. Mauritius and Andaman Islands are the only trustworthy localities; specimens labelled 'Australia' and 'New Zealand' appear to be from Mauritius.

All are large adults. The 9 from Mauritius are fine specimens, the largest 28 mm. in diameter, with the bare interambulacral areas light, like the ambulacra, or else bright brown. The specimens supposed to be from Australia and New Zealand are very large (up to 47 mm.) bare tests. That from the Andaman Islands is also a bare test, 26 × 17 mm., having no abactinal system; the tuberculated portions of the plates are rather olive-green, with the tubercles smaller and much more numerous than in Mauritius specimens; the naked areas are olive-grey, very conspicuous and sharply defined.

A bare test without locality is 47 mm. in diameter and 30 mm. high; there are 10 coronal plates in each column and 40 ambulacral. The tuberculation of this test is very complete, the bare interambulacral areas being reduced to spaces about 5 mm. wide by 3–4 mm. high on the upper and lower margins of the inner end of each plate; the ambulacra are completely covered with tubercles. The tuberculated part of the test is dull olive, and the small but well-defined naked areas are dull purple.

Anthechinus roseus A. Ag. is the young of this species, as Agassiz long ago decided, but I agree with Mortensen in

doubting whether *M. rousseaui* Agass. is identical with *M. maculatus*. Specimens of *M. rousseaui* with the spines and pedicellariae on the test are needed, and also a good series of *M. maculatus* from 10 to 30 mm. in diameter. Until this material is forthcoming, it would be futile to revive, or attempt to define, *M. rousseaui*.

4. *Microcyphus zigzag*.

Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 358. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. VIII c, figs. 11-13.

Bare interambulacral spaces dark coloured; spines deep red, not banded.

6 specimens, of which 2 are bare. Localities represented are: Bass Strait and Port Philip Heads.

12. AMBLYPNEUSTES.

L. Agassiz, 1841. Mon. Ech., Anat. Echinus, p. ix.

Type, *Echinus griseus* Blainville, 1825 - *Echinus ovum* Lamarck, 1816. Anim. s. Vert., 3, p. 48.

Median interambulacral areas not bare; primary tubercles on every ambulacral plate, close to poriferous area; test high, rather thin; abactinal system and peristome small.

This very characteristic and interesting Australian genus is represented by more than a hundred specimens, and the effort to determine the species to which they belong has necessitated a complete revision of the group. Mortensen (1904, Dansk. Selsk. Skr. (7), 1, pp. 102-10) made the first effort to bring order out of chaos, and so defined the genus that its limits are now easy to see; but owing to lack of material he was less successful in delimiting the species. In 1912 (Mem. M.C.Z., 34, pp. 325-32) I made an attempt to group the material available to me (as well as one form not seen by me) in 8 recognizable species, and two years later Döderlein (1914, Fauna Südwest-Austral.: Echinoidea, pp. 460-75) offered an artificial key to 9 different forms; he rightly discarded *A. grossularia* Studer, which Mortensen has since (1921, Vid. Med., 73, p. 170) shown is not even a Temnopleurid.

In addition to the material in the British Museum and the Museum of Comparative Zoölogy I have recently had the opportunity to study a very good collection of 75 specimens belonging to the South Australian Museum, Adelaide, and altogether I have studied more than 300 adult specimens.

The species names in use to-day are probably not used in the same sense as Lamarck, Blainville, or L. Agassiz used them. It is certain that the well-marked species which Mortensen, Döderlein, and I have agreed in naming *A. pallidus* is not

the species so designated by Lamarck ; but as it is unlikely that the bare test (or tests) on which he based his species could be positively identified, we may continue to use *A. pallidus* as we do, although Lamarck's diagnosis and Blainville's description lead me to think that the form to which I gave the name *A. pachistus* may perhaps be Lamarck's *A. pallidus*. *A. griseus* Blainville is, I think, synonymous with *A. ovum* Lamarck ; they cannot be distinguished by the shape of the test, for there is a continuous series from the lowest to the highest tests. There are in the Museum of Comparative Zoölogy specimens of *Amblypneustes* named *ovum* and *griseus* by Louis Agassiz, and other specimens purchased in Paris in 1870 by Alexander Agassiz, after comparison with Lamarck's 'originals', so that I feel very sure of my ground in using the name *A. ovum* as I do.

Döderlein made a great step forward in recognizing the importance of the presence or absence of spines on the anal plates, which I am convinced is of prime significance. It is now possible, I think, to make a key that will work satisfactorily when the specimen in hand is complete. I do not think any key can be made to identify bare tests with the periproct missing !

As stated above, *A. griseus* is a synonym of *A. ovum*, and this is the commonest *Amblypneustes* of Victoria and Tasmania. Farther west, *A. pallidus* is the common form, but both are common on the South Australian coast. These are the two easily distinguishable species of the genus, but allied with each are other more perplexing forms. The beautiful *A. formosus* is closely related to *A. pallidus*, and may prove to be only an extreme variety of it.

The forms allied to *A. ovum* are very diverse and their interrelationships are by no means clear. To three of them I have given the names *pachistus*, *grandis* and *triseriatus*. A fourth, *A. leucoglobus*, is known to me only from Döderlein's description and figures. Apparently the bare test is not distinguishable from that of *A. ovum*, but the miliary spines appear to be characteristic ; this may prove to be an extreme form of *A. ovum*.

Döderlein is probably right in considering *A. pachistus* to be a variety of *A. ovum*. The fully developed form is very distinct, but in large series it appears to intergrade with *A. ovum*. As for *A. triseriatus*, I have not found a second individual like it, and critical re-examination of the type leads me to believe that it is either a hybrid (possibly with *A. formosus*) or an extreme individual of *A. pachistus*. The status of *A. grandis* is more puzzling ; adults are so large, and so different in form and appearance from *A. ovum*, that one is inclined to regard them as a valid species until the attempt

is made to specify the distinguishing characters. *A. grandis* also is here listed as a variety of *A. ovum*.

The artificial key to the species and varieties of *Amblypneustes* may be used for specimens in which the periproctal plates are present, and at least some spines. The amplified diagnoses include all the essential facts about each form.

Key to the Species and Varieties of *Amblypneustes*.

- A. Periproctal plates rather small and thin, with no spines; primary spines red, purple, or green, with secondaries different; colours usually bright, with that of the primaries commonly lighter at base than at tip of spine; zigzag markings of interambulacra (or some sort of colour ornamentation) generally conspicuous; poriferous areas narrow.
- B. Primary spines bright red; test usually dark, with lateral parts of interambulacra often noticeably darker than middle; tuberculation of test rather coarse, many tubercles on the median interambulacral area more than half as large as the largest tubercles on the plates; size small, about 30–35 mm. in diameter; height of test about 0·85–0·95 of diameter; apparently ranging from Bass Straits and Tasmania to Western Australia, but rare and local. *formosus*
- BB. Primary spines pale red, purple, lavender, or green, with secondaries lavender or nearly white; test usually light, pale brown, purple, dull reddish, yellowish, greenish, or dirty white; tuberculation of test notable for the small size of the tubercles, especially in the median interambulacral areas; size moderate, test up to 45 mm. in diameter; height of test about 0·90–0·95 of diameter, but sometimes as much as 1·07; ranges from St. Vincent Gulf, South Australia, to the Abrolhos Islands, West Australia; apparently common on the South Australian coast. *pallidus*
- AA. Periproctal plates coarser and fewer, some, and often many, bearing spines; primary spines not bright coloured, pale brown, or reddish, or dark brown or green, often darkest at base and frequently light, or even white, tipped; zigzag markings or other ornamental patterns on interambulacral areas indistinct or wanting; poriferous areas narrow or wide, often quite wide with the pores in 3 fairly distinct vertical series.
- B'. 'Miliary spines much shorter than half the length of the primaries, with spheroidal, white tips; height of test about 90 per cent. of diameter; primary spines green or brown'; West Australia, Bunbury to Geraldton. *leucoglobus*
- B'B'. Miliary spines at least half as long as primaries, the tips sometimes thickened but never spheroidal; height of test in proportion to diameter very diverse; primary spines dull or pale.
- C'. Test high and often large; diameter may be as much as 60 mm., and the height is from 0·92 to 1·18 of the diameter; tuberculation of test fine, often very fine as in *A. pallidus*; colours diverse, but usually dull, brownish, yellowish, or dirty

- white spines on a grey, brown, or greenish test; pedicels often darker coloured in marked contrast; Bass Straits and Tasmania, westward apparently to Geraldton, West Australia, very common on the coasts of Victoria and South Australia. *ovum*
- C'C'. Test lower, more hemispherical, or even somewhat flattened, the height 0.60-0.80 of the diameter; tuberculation coarse.
- D'. Size very large, up to 85 mm. in diameter; poriferous areas very narrow, the 2 together forming one-third or less of ambulacrum; test and primaries pale brown, or dull pale red or dirty whitish; Victoria, South Australia, West Australia.
var. *grandis*
- D'D'. Size smaller, 40-45 mm. in diameter; poriferous areas nearly or quite half the ambulacrum; primary tubercles very large, especially in ambulacra, where the marginal series is very conspicuous, each tubercle occupying practically the entire height of the plate; test dull green or brown; primaries dull green, often dark, especially at base, whitish at tip; small spines often very light, sometimes nearly white; Bass Straits, Victoria, and South Australia.
var. *pachista*

1. *Amblypneustes formosus*.

Valenciennes, 1846. Voy. *Vénus*: Zooph., pl. II, fig. 2. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. VIII c, fig. 1.

Primary spines red; test dark, ornamentally marked with lighter; tuberculation rather coarse; no spines on anal plates.

18 specimens, of which 10 are bare and 2 are without locality labels; the others are labelled 'Australia' and Bass Straits.

These range from 17×17 mm. (2 bare young ones are smaller) to 36×37 mm. The largest is not only the largest individual of the species that I have seen, but is notable for its height, the vertical diameter slightly exceeding the horizontal.

2. *Amblypneustes ovum*.

Echinus ovum Lamarck, 1816. Anim. s. Vert., 3, p. 48.

Amblypneustes ovum Agassiz, 1841. Mon. Ech., Anat. Echinus, p. ix. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. VIII c, figs. 3 and 4.

Anal plates carry small spines; miliary spines at least half as long as primaries; test about as high as wide or even higher; tuberculation fine; colours dull.

75 specimens, of which 50 are bare tests and 32 have no locality labels. Localities represented are: Australia; New South Wales, Port Jackson; Tasmania; Victoria, Port Philip; Warrnambool; *Challenger* St. 162, Bass Straits, 38-40 fms., sand; South Australia. There are also labels 'Fiji Islands' and 'Cape of Good Hope', which are obviously wrong. Most of these specimens were labelled *A. griseus*, a fair number *A. pallidus*, and a few *A. ovum*. The specimen labelled Port Jackson does not, in my opinion, provide satisfactory evidence

of the occurrence of *Amblypneustes* there. All other '*Amblypneustes*' that Döderlein and I have seen from Port Jackson are *Holopneustes*!

Several of these specimens exceed 50 mm. in diameter. The height of these large ones nearly equals their width, excepting one 53 mm. in diameter but only 37 mm. high, the lowest of the whole series. The highest specimen is 45 mm. through and 46 mm. high. In most the ambitus is a circle, but in a few it is a distinct pentagon with rounded corners. Many are bare tests, the identification of which is doubtful.

Two specimens are curiously deformed, so that they are not pentamerously symmetrical. One from *Challenger* St. 162 measures 13 mm. by 11. Ocular IV is wanting and there is no ambulacrum IV above the ambitus; orally 5 ambulacra are present and there are 5 teeth visible. The other specimen is much more distorted, especially the abactinal system; ambulacrum V falls short of the abactinal system by 7-8 mm.; the test is 43 mm. long through III-5, and 38 mm. wide; anteriorly it is 31 mm. high but posteriorly only 18 mm. Both of these individuals fall into Jackson's (1912, *Phylog. Ech.*, pp. 35-51) class 16, but they differ from the examples listed by him.

2a. *A. ovum* var. *pachista*.

Amblypneustes pachistus H. L. Clark, 1912. *Mem. M.C.Z.*, 34, p. 327, pl. CXII, figs. 10 and 11, pl. CXXI, figs. 1-3.

Similar to *A. ovum* in essentials, but test stouter; tuberculation much coarser, especially in ambulacra; poriferous areas wide, the two together about half of ambulacrum.

8 specimens, of which 7 are bare and 3 are young without locality labels. Localities represented are: New South Wales, Clarence River; Tasmania, Hobart.

The bare tests from Hobart are fine, typical specimens; the largest is 45 mm. in diameter and 36 mm. high. The Clarence River specimen is labelled *Salmacis globator*; it is 50 mm. in diameter and is nearly bare; the primaries present are olive-green, dark at the base and white at the tip, as is usual in the variety. I doubt if the locality given is correct; it means an unexpected northern extension of the range of the genus.

3. *Amblypneustes pallidus*.

Echinus pallidus Lamarck, 1816. *Anim. s. Vert.*, 3, p. 48.

Amblypneustes pallidus Valenciennes, 1846. *Voy. Vénus: Zooph.*, pl. II, fig. 1. Döderlein, 1914. *Fauna Südwest Austral.* 4, pl. IX, figs. 1-5.

No spines on anal plates; primary spines pale red, purple, lavender or light green; secondaries lavender or nearly white;

test light coloured ; tuberculation fine ; height of test nearly or quite equal to diameter.

16 specimens from Australia and South Australia, of which 3 are bare.

These specimens range from 11×8 mm. to 34×36 , and show great diversity in colour. One has the primaries bright red, greenish only at base, with lavender secondaries ; I should refer it to *A. formosus* if the tubercles were not so small. Two very fine specimens in the Exhibition Gallery have the primaries orange-red, greenish at base, and the secondaries bright lavender. Eight specimens from South Australia have the primaries green (one has them purple) and the secondaries pale lavender or pale green with lavender tips, or simply pale green. A couple of small bare tests from South Australia are red, more or less of an orange shade, with the ambulacra and zigzag markings on the interambulacra whitish ; the few remaining spines are white, but these are probably not primaries.

13. HOLOPNEUSTES.

Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 364.

Type, *Holopneustes porosissimus* Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 364.

Test high ; poriferous areas wide and crowded ; only every second or third ambulacral plate above ambitus with a primary tubercle close to poriferous area ; interambulacral plates low and numerous ; ocular plates all exsert.

1. *Holopneustes inflatus*.

A. Agassiz, 1872. Bull. M.C.Z., 3, p. 56. 1873, Rev. Ech., pt. 3, pl. VIII c, figs. 5 and 6 (as *H. purpurescens*).

Ambulacra and interambulacra of about equal width ; primary spines range from pale brown to reddish-purple.

45 specimens, of which 31 are bare and 19 have no locality labels. Localities represented are : New South Wales, Port Jackson ; Van Diemens Land ; Victoria, Port Philip Heads ; Warrnambool. Nearly all were labelled *Amblypneustes*.

This series shows very great diversity in colour of the test, but much of this may be due to bleaching. In 11 specimens from Port Jackson the colour ranges from pure white to bright reddish. The normal coloration in life includes more or less red or purple. An individual from Port Jackson is deformed ; it is 33 mm. in diameter, but is 30 mm. high in interambulacrum I and 35 mm. high in ambulacrum IV. Furthermore, ambulacrum IV is duplicated in half, that is, it has 3 poriferous zones at the ambitus ; the oculars and genitals are normal, but the extra half ambulacrum extends to the

peristomic. A specimen exhibited has a label calling attention to 'the peculiar fusing of 2 ambulacra'; the condition is not the fusing of 2 ambulacra, but the dropping out of the interporiferous area of an ambulacrum in the midzone, so that the poriferous areas lie side by side.

The largest is 54 mm. high, though it is but 52 mm. in diameter. A fine example from Port Jackson, 40 × 41 mm., has the test a pale lavender and the spines pale pink. A bare test from Warrnambool has much white on the upper half; the mid-interambulacral areas are white to some distance below the ambitus.

2. *Holopneustes porosissimus*.

Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 364. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. VIII c, figs. 9 and 10.

Ambulacra noticeably wider than interambulacra; primary spines greenish, more or less extensively tipped with red.

7 specimens, of which 3 are bare. Localities represented are: Victoria, Port Philip Heads; Hobson Bay; Warrnambool; South Australia, Adelaide; West Australia, Fremantle.

These are mostly young, 11–18 mm. in diameter, but the one from Hobson Bay is fine. In a specimen 11 mm. in diameter the ambulacra are 4 mm. wide and the interambulacra 3, about the same proportions that hold for the adult.

14. GONIOPNEUSTES.

Duncan, 1889. Jour. Linn. Soc. London, Zool., 23, p. 113.

Type, *Amblypneustes pentagonus* A. Agassiz, 1872. Bull. M.C.Z., 3, p. 56.

Only every second or third ambulacral plate above ambitus with a primary tubercle close to poriferous area; interambulacral plates few and high; oculars I and V insert.

1. *Goniopneustes pentagonus*.

Amblypneustes pentagonus A. Agassiz, 1872. Bull. M.C.Z., 3, p. 56. 1873, Rev. Ech., pt. 3, pl. VIII c, figs. 7 and 8.

Goniopneustes pentagonus Duncan, 1889. Jour. Linn. Soc. London, Zool., 23, p. 113.

Test smooth, reddish-purple, its height about two-thirds its diameter; spines white.

2 specimens from Macclesfield Bank, 30–50 fms. One was labelled *Tripneustes gratilla* (cf. Bell, P.Z.S., 1894, p. 411), the other was not identified.

These are superb examples of this very rare species, hitherto known only from the type in the Museum of Comparative Zoölogy. This type is labelled 'Ile de France?', a locality there is every reason to doubt; the discovery that this species inhabits the China Sea is important.

The larger specimen measures 27×20 mm., the smaller 18×11 . The ambitus is circular; oculars I and V are insert; the test is smooth, without sculpturing and without pits. No genital pores are visible, which indicates that adults of this species are considerably larger. In the smaller specimen, which has 16 coronal plates in each series, there are only 31 ambulacra. Each ambulacral plate below the midzone has a primary tubercle, but in the midzone only every other one, and above the midzone there are but 2 or 3 such tubercles on either side of each ambulacrum. No globiferous pedicellariae could be found. Ophicephalous pedicellariae abundant but not distinctive. Tridentate pedicellariae rare, only 2 being found; they are not peculiar in any way; the valves are narrow, compressed at base of blade but expanded at tip. The colour of both specimens is dull reddish purple, with the spines, anal plates, and all tubercles white or whitish.

Family 2. ECHINIDAE, Agassiz.

Ambulacral plates compound, typically of 3 elements; ambitus circular; test without sculpturing or pits.

The limits of this family have been so much discussed that it is necessary to review the present state of our knowledge of the group and its allies. Dr. Mortensen's notable monograph on the larval forms of Echinoderms (1921, *Studies Dev. Larval Forms Ech.*, pp. 32-77, 206-12) throws a great deal of light on the interrelationships of the genera discussed. Mortensen thinks that in the main his views derived from a study of the pedicellariae have been confirmed, and that each of the three families that he recognizes has a definite larval form; but it seems to me that here, as with the test or the pedicellariae considered alone, we find a series of forms ranging from the simpler to the more complex, which can be arbitrarily divided into three groups, by recognizing certain exceptions. My Danish colleague and I are quite in agreement as to certain 'simple' genera which belong to the Echinidae and also as to other 'complex' genera which make up the Echinometridae (in my sense of that name), but it is in regard to the intermediate genera that we differ. I have pinned my faith to the test structure, especially to the essential difference between triporous and polyporous ambulacra, and now I find that in a South African species (*Paracentrotus agulhensis*) the same *adult* individual may show both kinds! (see H. L. Clark, 1924, *Fish. Mar. Biol. Surv. U.S. Afr.*, Rep. 4, Sp. Rep. 1, pp. 6 and 9). This is probably due to senescence, but it is perplexing nevertheless. Mortensen originally laid stress almost wholly on the pedicellariae, but now admits that in certain genera

(*Notechinus*, *Pseudechinus*) 'the characters of the pedicellariae are very indistinct' (*op. cit.*, p. 212).

There is general agreement as to the recognition of three families, of which the least specialized is the Echinidae and the most specialized is the Echinometridae. The difficulty is the intermediate group which Mortensen names Toxopneustidae and Gregory Strongylocentrotidae. This is not merely a difference of name but of the position of important genera, for Gregory, Jackson and I have considered *Toxopneustes* one of the Echinidae, and Mortensen's name Toxopneustidae could not then be used. Therefore the first point to be settled is the position of *Toxopneustes* and *Lytechinus*—two closely related genera, of which *Toxopneustes* is obviously the more specialized.

In the characters of the test *Lytechinus* is essentially an *Echinus*, but is distinguished by the distinct and usually deep gill-cuts. Also the pedicellariae are different, the valves of the globiferous pedicellariae in *Lytechinus* being very distinctive. The larvae of *Lytechinus* are almost intermediate between those of *Echinus* and those of *Tripneustes* or *Toxopneustes*; indeed the relationship to *Echinus* seems to me much more evident than that to these other genera. The gill-slits and the peculiar globiferous pedicellariae perhaps make it worth while to separate *Lytechinus* from *Echinus*, and to associate it with *Toxopneustes*, *Tripneustes*, *Nudechinus* and *Gymnechinus* to form a subfamily of the Echinidae, to be termed Toxopneustinae.

In forming the family Strongylocentrotidae Gregory simply ignored the pedicellariae and Jackson did the same (1912, Mem. Boston Soc. Nat. Hist., 7). This course enables one to avoid a most perplexing dilemma, for within the limits of the family are two groups of genera, one with the remarkable globiferous pedicellariae of *Lytechinus* and its allies, and the other with a quite distinct type, similar to that of *Echinometra*.

The question is whether, as Mortensen holds, the first group is derived from the Toxopneustinae, or whether it is to be regarded as comprising polyporous forms whose globiferous pedicellariae have independently become like those of the Toxopneustinae. Mortensen considers that the study of the larval forms confirms his view. The three genera primarily concerned (with globiferous pedicellariae as in *Toxopneustes*) are *Pseudoboletia*, *Strongylocentrotus* and *Sphaerechinus*. The genera making up the other group of Strongylocentrotidae are *Echinostrephus*, *Loxechinus*, *Paracentrotus*, *Caenocentrotus*, *Pachycentrotus* and *Heliocidaris*. The larval forms of *Strongylocentrotus*, *Sphaerechinus*, *Paracentrotus* and *Heliocidaris* are known. That of *Paracentrotus* is essentially like that of the Echinidae, as might be expected from its position as one of

the most primitive genera in the family. In *Sphaerechinus*, according to Mortensen, the larva is very much like that of *Helicoidaris crassispina*. This *Helicoidaris*-like larva of *Sphaerechinus* makes it proper to distinguish *Sphaerechinus* from *Strongylocentrotus*; but it confirms my belief that the resemblance between the globiferous pedicellariae of *Pseudolelia*, *Strongylocentrotus* and *Sphaerechinus*, and those of the Toxopneustinae is not an indication of genetic connexion but of 'parallelism' in development.

Echinostrephus connects the Echinidae with the Strongylocentrotidae, one species having but 3 pairs of pores in each ambulacral plate, and the other 4. Nothing is known of the larva, but the pedicellariae and the habits warrant including this genus in the Strongylocentrotidae. *Loxechinus* is certainly a member of the family, but has retained a very primitive form of globiferous pedicellariae as a link with the Echinidae. A genus that I have hitherto left in the Echinidae, in spite of its specialized pedicellariae, is *Evechinus*. Mortensen has now shown that its larval form is also specialized, as in *Echinometra*; hence I put *Evechinus* in the Strongylocentrotidae, in spite of the fact that its ambulacra, though quite complex, are not, apparently, polyporous.

As regards the Echinometridae, the only genus that causes difficulty is *Parasalenia*. The larval form is not known; if it proves to be like that of *Lytechinus*, the genus may be placed in the the Toxopneustinae, the form of the test being regarded as a secondary acquirement. But for the present the form of the globiferous pedicellariae may be regarded as secondary, and the triporous ambulacra as the retention of a primitive character, or possibly a reversion. Comparison of young *Parasalenia* with young *Echinometra* suggests the derivation of the former genus from the latter.

This grouping of the genera involves the assumption that Toxopneustid-like globiferous pedicellariae have developed independently in three quite widely separated groups. However, the change from the pedicellaria-form seen in *Echinus* to the typical Toxopneustid form is relatively slight and might occur easily. Comparison of some of the published figures will help to confirm this; for example, Mortensen's figures (1903, *Ingolf* Ech.). Compare figures 17, pl. XVIII, with 14, pl. XX; or 19, pl. XIX, with 16, pl. XX; or 6, pl. XVIII, with 26, pl. XX. In Clark (1912, Mem. M.C.Z., 34) compare figs. 9 and 18, pl. XCIV, and fig. 4, pl. XCV, with fig. 27, pl. XCIII and figs. 6. and 16, pl. XCV; it will readily be seen (particularly in fig. 18, pl. XCIV) that the Toxopneustid type often shows an asymmetry at the tip, the left side being pushed out a little, as in pedicellariae which bear an unpaired tooth on that side. That the loss of this tooth might occur

independently in quite unrelated genera seems not only possible, but probable. Similar changes in spines¹ occur quite independently in various genera, and pedicellariae, like spines, are but appendages of the test, subject to all environmental influences. That Toxopneustid-like globiferous pedicellariae have arisen independently three times is at least as likely as the alternative, that polyporous ambulacra have arisen independently.

1. PSAMMECHINUS.

Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 368.

Type, *Echinus miliaris* P. L. S. Müller in Knorr, 1771. Del. Nat., pl. D II, fig. 3.

Periproct approximately central; buccal membrane plated; a primary tubercle on every ambulacral plate; ocular plates all exsert; gill cuts insignificant.

1. *Psammechinus microtuberculatus*.

Echinus microtuberculatus de Blainville, 1825. Dict. Sci. Nat., 37, p. 88. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. VII a, figs. 1 and 2.

Echinus (Psammechinus) microtuberculatus Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 368.

Buccal membrane covered with greenish plates; tuberculation of test fine, but primary tubercles much the largest.

37 specimens, of which 4 are bare and 14 have no locality labels. Localities represented are: Mediterranean Sea; Bay of Marseilles; Naples; Toulon; Trieste; Corfu.

The best of these are from Naples; the largest is nearly 35 mm. in diameter.

2. *Psammechinus miliaris*.

Echinus miliaris P. L. S. Müller in Knorr, 1771. Del. Nat., pl. D II, fig. 3.

Echinus (Psammechinus) miliaris Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 368. Mortensen, 1903. Ingolf' Ech., pt. 1, pl. II, fig. 7; pl. XV, figs. 6, 7, and 11.

Buccal membrane covered with whitish plates; tuberculation of test coarse; secondaries large and numerous.

166 specimens, of which 70 are bare tests and 69 have no locality labels. Localities represented are: Shetlands;

¹ A striking illustration of parallelism in the modification of spines has recently been published by A. O. Thomas (1924, Iowa Geolog. Surv., 29, pp. 481-93). The Devonian genus *Nortonechinus* has spines surprisingly like the specialized spines of our modern *Podophora*, and there is no genetic connexion between the two genera possible. See also the *radioli paletiformes* of *Anaulocidaris testudo* Bather (1909, Triassic Ech. Bakony, p. 140) for a third example of the independent origin of such extraordinary spines.

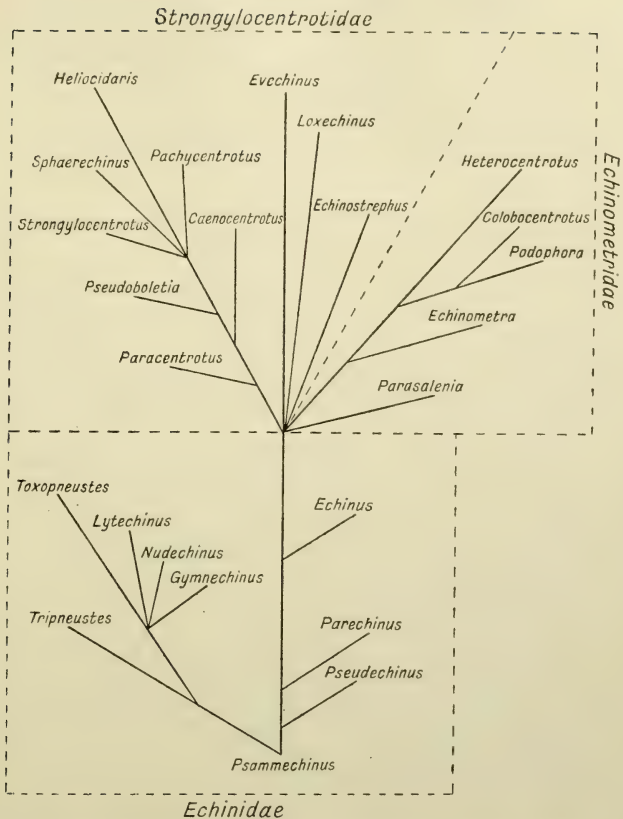


Diagram to illustrate the Interrelationships of the Genera in the families Echinidae, Strongylocentrotidae, and Echinometridae.

Scotland, west coast; Loch Fyne; Loch Gail; Kilbrannan Sound; Ireland, Birrterbury Bay; off Valentia Bay (*Porcupine*); England, off Liverpool; Plymouth; Brixham, off Berry Head, 30 fms.; Portland; Weymouth; Lulworth; Poole; St. Leonards; Norway; Denmark; Channel Islands; Portugal; Spain, Santander; Mediterranean; Corfu. Several of the specimens were labelled *E. esculentus*. The 11 specimens labelled 'Mediterranean' may have come from that sea, but Mortensen (1913, Mitt. Zool. St. Neapel, **21**, pp. 1-39) does not include *P. miliaris* in the Mediterranean fauna. The single specimen labelled Corfu is not very satisfactory as evidence.

The finest of these specimens are those labelled Scotland, but the largest is a bare test, 50 mm. in diameter and 26 mm. high, from an unknown locality. Another bare test is a remarkable deformed variant, 51 mm. long, on an axis which runs through genitals 1 and 3!; the greatest width is 45 mm. and the height is only 22. Ocular IV and genital 4 (or 5) are wanting, but ambulacrum IV is present on the oral side of the test. This aberrant individual does not fall into any of Jackson's (1912, Mem. Boston Nat. Hist. Soc., **7**, pp. 36-51) 20 groups; it is nearest Group 16, but has only 4 genital plates.

2. ECHINUS.

Linné, 1758. Sys. Nat., ed. 10, p. 663.

Type, *Echinus esculentus* Linné, 1758. Sys. Nat., ed. 10, p. 663.

Periproct approximately central; peristome not plated; gill cuts shallow; pore-pairs in ares of 3; ocular plates small, exsert (rarely I, or I and V, insert); size rather large, often exceeding 75 mm.

1. *Echinus acutus*.

Lamarck, 1816. Anim. s. Vert., **3**, p. 45. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. VII a, fig. 5. Mortensen, 1903. *Ingolf* Ech., pl. II, figs. 1 (as *E. flemingi*) and 8.

Test half as high as wide or more; ambulacra plates at and below ambitus often lack primary tubercles; buccal plates carry no spines; tubercles and areolae large; primary spines not uniformly green; periproctal plates with at least a few spines.

94 specimens, of which 6 are bare tests and 59 are without locality labels. Localities represented are: Norway; North Sea; *Porcupine* St. 82, north of Cape Wrath, 312 fms.; England, Tynemouth; Plymouth; Falmouth; English Channel; Ireland, off Cleggan Head, 40 miles; Royal Dublin Soc. St. 43; off south-western Ireland, Irish Fish. Board St. 504, 627-728 fms., stones and coral; south-west of Ireland, 500 fms.; Mediterranean Sea; Nice; Naples; Sicily;

Tunis, Bona Bay, 25-65 fms. One of the specimens from the English Channel was labelled *E. flemingi*, and 4 from off south-western Ireland were labelled *E. rarispinosus*.

Many of these are very handsome, notably those from Naples and from Sicily. Those from the Irish F. B. St. 504 are very brilliant red and white; the largest is 70 × 50 mm. A specimen without locality, 45 × 20 mm., is remarkable for the very long primaries, which are green at base abactinally, but pure white at tip; some of the oral primaries have the tips wide and flat: this may represent an undescribed variety. Another noteworthy specimen, 70 × 38 mm., from off south-western Ireland, 70 fms., is conical in shape. There is no red in the coloration, but the test and spines are white, with the primaries, and most smaller spines above the ambitus, deep green at base. The largest specimen is from the English Channel and measures 135 mm. in diameter and 102 mm. high.

1 a. *E. acutus* var. *norvegica*.

Echinus norvegicus Düben and Koren, 1844. Skand. Ech., p. 268.

A. Agassiz, 1873. Rev. Ech., pt. 3, pl. VI a, fig. 4.

Echinus acutus var. *norvegicus* Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 153; pl. I, figs. 4 and 8; pl. II, figs. 2 and 6.

Test low; ambulacral plates many, each with a primary tubercle; pore-pairs small; abactinal system large.

461 specimens, of which 234 are bare tests and 232 are without locality labels. The following localities are represented: Norway; Lofoten, 300 fms.; Hardanger Fjord; Christiansund, 50-60 fms.; Havbröln, 100 fms.; *Ingolf* St. 50, south of Iceland, 1,020 fms.; Shetland; *Porcupine* St. 47, north-west of Cape Wrath, 542 fms.; North Sea, 50-200 fms.; *Porcupine* St. 29, north-west of Ireland, 1,264 fms.; Ireland, 38 miles w. $\frac{1}{2}$ s. off Duisley Head, 105 fms.; off south-west coast, 110 fms.; 45 miles off Blackrock, 500 fms.; *Porcupine* St. 6, south-west of Ireland, 90 fms.; off Valentia, 40 fms.; off Ireland, 982 fms.; British seas, deep water; off eastern United States, 1,241 fms.; ditto, 1,242 fms.; *Challenger* St. 45, western Atlantic, 1,240 fms., mud; *Challenger* St. 46, western Atlantic, 1,350 fms., mud; *Challenger* St. 47, western Atlantic, 1,340 fms., mud; coast of Spain and Portugal.

These are labelled *E. acutus*, *norvegicus*, *affinis*, *elegans*, *flemingi*, *microstomus* and *rarispinosus*. They range in colour from pure white to purple, green and white; as a rule there is more or less red, and often they are very handsome in their bright red spines. Among the more interesting specimens are 3 bare tests taken by the *Porcupine* in 1869, apparently the types of Thomson's *E. microstomus*; 2 specimens from *Ingolf* St. 50, cotypes of *E. affinis* Mortensen; 7 specimens from Hardanger Fjord, labelled *E. elegans*; 5 quite flat rather green specimens from Lousey Bank, 100-200 fms., a peculiar form of *E. norvegicus*. A superb individual from Gravene Fjord,

Hardangerfjord, 40×25 mm., has primary spines 25 mm. long; there are very few secondaries and fewer miliaries still, but pedicellariae are numerous; the abactinal primary spines are deep purple at base, then green, then greenish-white at tip, but there is no purple below the ambitus, and the actinal spines soon lose their green; there is no red anywhere.

A critical study of sufficient material may enable the various forms of *E. acutus* and *E. norvegicus* to be arranged in some sort of groups or series correlated with locality, depth or character of the bottom, but at present I find it impossible to draw satisfactory lines.

Besides the material listed above under *E. acutus* and *E. a.* var. *norvegica*, there are 9 lots of small individuals, 81 in all, that are too young to be properly assigned to either form.

2. *Echinus alexandri*.

Danielssen and Koren, 1882. *Nyt Mag. f. Naturv.*, **27**, p. 294.

Mortensen, 1903. *Ingolf Ech.*, pt. 1, pl. V, figs. 2 and 3, pl. XV, figs. 13 and 17.

Ambulacral plates each with a primary tubercle; height of test about one-half diameter; abactinal system much smaller than peristome; valves of large, tridentate pedicellariae broad and flattened.

6 specimens from the following localities: St. 44, west of the Faeroe Islands, 545 fms., hard bottom, St. 52, south-east of Iceland, 420 fms., and St. 96, west of Iceland, 735 fms. (*Ingolf*); Bay of Biscay, 950 fms. (*Koehler*); St. 46, western Atlantic, 1,350 fms., mud, and off Tristan da Cunha, 1,100 fms. (*Challenger*). The *Challenger* specimens were both labelled *E. elegans*.

Mortensen considers the one from Tristan da Cunha to be a representative of an undescribed species. This specimen is 70×34 mm., and is in very fine condition; the abactinal spines are fewer than usual, and the valves of the tridentate pedicellariae are narrower than in typical *E. alexandri*.

3. *Echinus atlanticus*.

Mortensen, 1903. *Ingolf Ech.*, pt. 1, p. 101. H. L. Clark, 1912. *Mem. M.C.Z.*, **34**, pl. CX, figs. 1-3.

Test high, sparsely tuberculated, remarkably bare above ambitus; primaries relatively long; each ambulacral plate with a primary tubercle.

13 specimens from *Challenger* St. 343, near Ascension Island, 425 fms., coral.

This is a fine series; the specimens range from 17 to 73 mm. in diameter and show little diversity.

4. *Echinus elegans*.

Düben and Koren, 1844. Skand. Ech., p. 272. Mortensen, 1903. *Ingolf* Ech., pt. 1, pl. I, figs. 2 and 3, pl. III, fig. 4, pl. XV, fig. 4, pl. XVI, figs. 3 and 19.

Test rather low; ambulacral plates numerous, each with a primary tubercle; pore-pairs, large; abactinal system small; coloration generally with more or less red.

5 specimens from the following sources: *Porcupine* St. 47, north-west of Cape Wrath, 542 fms.; off southern Ireland, 500 fms.; Ireland, 45 miles off Blackrock, 500 fms.; Bay of Biscay, 665 fms. (*Koehler*).

The specimen from *Porcupine* St. 47 is too young for certain identification. Two from off Blackrock show little red; one is 58×33 mm., the height being 57 per cent. of diameter; the other is 62×43 mm., the height thus being approximately 70 per cent. The Bay of Biscay specimen is intermediate in height and shows much red; that from the Royal Dublin Society has very red spines.

5. *Echinus esculentus*.

Linnaeus, 1758. Syst. Nat., ed. 10, p. 663. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. VII a, fig. 7. Mortensen, 1903. *Ingolf* Ech., pt. 1, pl. III, fig. 3; pl. XV, figs. 1 and 5.

Test high, with numerous tubercles and short spines; buccal plates with spines; colours, red, purple or green.

88 specimens, of which 2 are bare and 8 are without locality labels. Localities represented are: Rockall; Shetland; Norway; Hardanger Fjord; Dogger Bank; Scotland; Firth of Forth; Loch Fyne; Kilbrennan Sound, 10–20 fms.; 4 m. s.-e. of Sanda, 30–38 fms.; Isle of Man; England, coast of Northumberland, Fern Island; Scarborough; Lytham; Liverpool; Ilfracombe; Plymouth; English Channel; British seas; South Ireland; Ireland, Dingle Bay. There are also labels reading: Naples; Port Natal; and 'John Adams Bank, coast of Brazil, *Herald*'. Obviously there is some mistake about these.

This interesting series shows that there are three rather distinct types of coloration—pale purple, pale green, and red. In four fine specimens from Fern Island the prevailing tint is light purple, almost a lavender. A specimen from Scarborough, 72 mm. in diameter by 50 mm. high, is light green. An example from the Dogger Bank is quite red. Intermediate specimens with red tests and purple or green spines occur, but most individuals may be placed easily in one of the three groups. This species reaches a larger size than any other regular sea-urchin, excepting only the largest of the flexible Echinothuriids. A specimen from Plymouth in the Exhibition Gallery is 176 mm. in diameter.

6. *Echinus euryporus*.

H. L. Clark, 1912. Mem. M.C.Z., 34, p. 266, pl. CIX, figs. 4-6.

Similar to *E. elegans* but coarser; primary ambulacral tubercles of irregular sizes; colour of test dull purplish-brown.

3 specimens from *Challenger* St. 308, off southern Chile, 175 fms., mud, labelled *E. norvegicus*.

These specimens are 40-52 mm. in diameter; in colour and in all important particulars they are essentially like the holotype.

7. *Echinus gilchristi*.

Bell, 1904. Mar. Inv. S. Afr., 3, p. 170. Döderlein, 1906. *Valdivia* Ech., pl. XXVI, figs. 1-1 b.

Colour greenish-grey; primaries whitish; test very closely and finely tuberculated; no spines or buccal plates.

6 specimens from Cape of Good Hope, stations 34, 70, 83, 85, and 138 (the exact localities are given in Bell's Report), 33-85 fms.

These are the types of this fine species; the largest is 73 × 52 mm. All have the primaries very white and conspicuous against the greenish-grey test; in 2 the primary spines of the abactinal surface are much smaller than those at the ambitus, but in a third they are just as conspicuous; hence this third specimen appears unusually bristling with spines. The other three specimens are somewhat intermediate in the matter of the primaries.

7 a. *E. gilchristi* var. *hirsuta*.

Echinus hirsutus Döderlein, 1905. Zool. Anz., 28, p. 623.

Echinus gilchristi var. *hirsutus* Döderlein, 1906. *Valdivia* Ech., p. 213, pl. XXVI, figs. 2-4 b.

Similar to *E. gilchristi* but much coarser, and more sparsely tuberculated.

1 specimen from Cape Colony, 11 miles off Cape St. Blaize.

This individual is 42 × 26 mm., quite green with white spines, the primaries a fine shining white. It is not a typical *E. hirsutus*, but seems nearer to that form than to typical *E. gilchristi*.

8. *Echinus gracilis*.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 269. 1872, Rev. Ech., pt. 2, pl. VI a, fig. 6.

3 specimens from the following localities: off Marthas Vineyard, St. 244¹; Florida, off Sand Key, 120 fms.

¹ I have been unable to locate this station, but there are specimens in the U.S. National Museum from off Marthas Vineyard, 89-134 fms., and these specimens apparently came from that museum.

These are very fine specimens of this handsome urchin. The largest is 88×58 mm. ; another, 85 mm. in diameter, is only 63 mm. high.

9. *Echinus horridus*.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 203. H. L. Clark, 1916. *Endeavour* Ech., pls. XXXIX and XL.

Test very high ; in adults height exceeds diameter ; test very finely tuberculated ; primary spines few, shining, moderately long, bright red ; test red.

3 specimens and fragments of others from *Challenger* St. 308, off southern Chile, 175 fms., mud.

The unbroken specimens are small (45×33 mm.), but one of those represented by fragments was a very large one, apparently between 90 and 100 mm. in diameter. The species is remarkable for the extraordinarily high test of the adult (the height may be more than 40 per cent. greater than the diameter). Specimens are as yet known from this one station off southern Chile, from a very limited area at the south-eastern corner of Australia and from an almost equally limited area off Cape Colony. Specimens from these three widely separated places are extraordinarily alike in form and colour, as well as in other characters.

10. *Echinus lucidus*.

Döderlein, 1885. Arch. f. Naturg., **51** (1), p. 97. H. L. Clark, 1912. Mem. M.C.Z., **34**, pl. CVII, figs. 1-3.

Similar to *E. elegans*, but with no trace of red ; numerous plates in buccal membrane, none of which carries pedicellariae.

2 specimens from *Challenger* St. 232, off Japan, 345 fms., sandy mud, labelled *E. norvegicus*.

These are small but typical specimens ; the smaller, with a diameter of 14 mm., has primary spines 12 mm. long.

11. *Echinus diadema*.

Studer, 1876. Monatsb. Akad. Wiss. Berlin, p. 456. Döderlein, 1906. *Valdivia* Ech., pl. XXIX, figs. 1 and 1 a (as *Sterechinus margaritaceus*).

(= *Echinus margaritaceus* A. Agassiz, non *E. margaritaceus* Lamarck.)

Test low ; primary tubercles often lacking on actinal ambulacral plates ; buccal plates with spines ; one or more ocular plates often insert.

158 specimens. Localities represented are as follows : West End of Magellan Strait, St. 311, 245 fms., mud (*Challenger*) ; Straits of Magellan ; Falkland Islands ; South Georgia, off Larsen Point (*Quest*) ; Deception Island ; Prince Edward Island, 85-150 fms. ; St. 147, near Crozet Islands, 1,600 fms. ; Kerguelen ; St. 150, near Heard Island, 150 fms. ; and St. 151,

off Heard Island, 75 fms. (*Challenger*); Franklin Island, 10–20 fms., and South Victoria Land, off Cape Adare, 20 fms. (*Southern Cross*); St. 220, off Cape Adare, 45–50 fms. (*Terra Nova*); South of Antarctic Circle, 254 fms.; off Coulman Island, 100 fms.; Coulman Island, off Cape Wadsworth, 8–15 fms.; East End of Barrier, 100 fms.; and Winter Quarters (*Discovery*); Ross Sea, St. 338, 207 fms.; St. 339, 140 fms.; St. 340, 160 fms.; St. 355, 300 fms.; McMurdo Sound, St. 8, 140 fms.; St. 10, 200 fms.; St. 13, 300 fms. (*Terra Nova*).—There are also 2 specimens with the label '*Terra Nova* St. 42', but as this station is near Rio Janeiro, it is obvious that there is some mistake. As the specimens are fine adults, the probability is that they are from St. 342 in McMurdo Sound. Most of the specimens are labelled *Echinus margaritaceus*, and others *Echinus angulosus*, *Echinus magellanicus*, *Sterechinus neumayeri*, and *Sterechinus agassizii*.

It seems to be quite certain that Lamarck's *E. margaritaceus* was not this Antarctic form. That matter has been amply elucidated by Mortensen (1910, Swedish S. Polar Exp. Ech., pp. 42–4). It is a question whether this series of specimens represents one, or more than one, species. They show much diversity in size and colour, less in form, and still less in more fundamental characters, so that they may be treated as one species. Nor am I able to delimit recognizable varieties correlated constantly with locality, although a more critical examination may lead some other student to a different conclusion. Apparently *Echinus diadema* is comparable in distribution and diversity with our northern circumpolar (?) species *Strongylocentrotus dröbachiensis*.

The single specimen from the Falkland Islands, received from J. E. Hamilton in May, 1924, may represent a recognizable variety. It is 30×15 mm., with the test abactinally greenish-grey and nearly white orally; the spines below the ambitus are also white, including those on the buccal plates, but above the ambitus the small spines are grey and the primaries are bright violet. Oculars I, V, IV and II are insert, but II much less than IV. The suranal plate is small and central, little larger than the other numerous periproctal plates.

There are 20 specimens from Deception Island, and their very dark, nearly black, tests and white or colourless spines are very striking. The ground colour ranges from violet-brown to deep brown-purple. They range from 10 to 37 mm. in diameter, but those under 20 mm. are obviously immature. They show considerable diversity as regards the ocular plates and the suranal; a specimen 22 mm. in diameter has a distinct suranal and only ocular I insert; the largest specimen (37 mm.) also has only ocular I insert, but there is no distinct suranal; a specimen intermediate between these two has oculars I and V insert, but still shows the distinct suranal plate.

Some of the best and most typical specimens are from the Kerguelen area. One of the finest, from *Challenger* St. 151, is 53×26 mm., with the actinostome 17 mm. across and the abactinal system only 11.5. The test is dark brown (blackish), but the rather few primaries are white; black, globiferous pedicellariae are abundant, but tridentate pedicellariae with wide, uncompressed, pointed valves are rather rare.

The 8 specimens from off Cape Wadsworth, Coulman Island, are quite different, as the test is relatively higher, the colouring is more purple and the primary spines are much more numerous; oculars I and V are both insert.

The 15 specimens from the *Discovery* winter quarters are very diversified in size and colour. The tests range from nearly white to deep reddish-brown and even to almost black, but the primary spines are white.

The 2 specimens from '*Terra Nova* St. 42' (342 ?) are very large and fine and notably depressed: the larger, although 75 mm. in diameter, is only 30 mm. high.

12. *Echinus melo*.

Lamarek, 1816. *Anim. s. Vert.*, 3, p. 45. Koehler, 1895. *Rev. Biol. Nord France*, 7, pl. IX, figs. 1 and 2.

Test large, high, sparsely tubercled; tubercles very small; primary tubercles lacking on many actinal ambulacral plates; primary spines small, green.

2 specimens, from Naples and from the Gulf of Genoa.

13. *Echinus multidentatus* sp. nov. PLATE VI. figs. 1 and 2.

Test hemispherical but high, flattened orally; horizontal diameter, 78 mm.; vertical, 52 mm. Coronal plates 16 in each column, with 34 ambulacrals corresponding to them. Primary tubercles on coronal plates large but well spaced, accompanied by rather few and small secondaries. On ambulacral plates primary tubercles present only on every second or third plate, except orally, where they may occur on 2 in succession. Abactinal system 19 mm. across, of which the periproct occupies about one-half; ocular plates small and, of course, very fully exsert. Peristome about 22 mm. in diameter, with a few scattered pedicellaria-bearing plates in the membrane beside the buccal plates, which carry many ophicephalous and some tridentate pedicellariae but no spines. Primary spines all broken, but they must have exceeded 40 mm. in length. Secondary spines few, short and small.

Pedicellariae of all kinds abundant, but the globiferous are chiefly in the midzone. The valves of the globiferous are much like those of *E. atlanticus* (see Mortensen, 1903, *Ingolf Echn.* pt. 1, pl. XVIII, fig. 17), but there are 3-5 teeth on each side near the tip, and the base is more like that seen in *E.*

elegans (pl. XVIII, fig. 2), but is less angular. The tridentate valves may be as much as 2.5 mm. long and are narrow and somewhat compressed; they resemble those of *E. affinis* (Mortensen's Plate XVIII, fig. 28), but there are 5 or 6 much more conspicuous finely serrate teeth at the tip. The ophi-cephalous and triphyllous pedicellariae are not distinctive.

Colour white; muscles pale brown. The indications are that the specimen is almost completely bleached.

Challenger St. 170, near the Kermadec Islands, 630 fms., rock. Labelled *Echinus acutus*.

Mortensen (1903, *Ingolf* Ech., pt. 1, p. 159) says of this individual that 'it is a large, fine specimen of *Ech. affinis*, as far as I was able to decide by a short examination; at all events it has nothing to do with *Ech. acutus*'. This last statement is too emphatic, for *E. affinis* is so closely related to *E. acutus* var. *norvegicus* that I am unable to distinguish it! In my judgement *E. multidentatus* is more like *E. acutus* than like *E. affinis*. Its resemblance to *E. acutus* is deceptive, for the globiferous pedicellariae ally it rather with *E. alexandri*. The occurrence of an *Echinus*, so close to North Atlantic species, in the Pacific near the Kermadec Islands at a depth of over 600 fms., is very remarkable; so much so as to make one doubt whether this specimen came from there.

14. *Echinus tenuispina*.

Echinus esculentus var. *tenuispina* Norman, 1868. Rep. Brit. Ass., p. 314.

Echinus tenuispinus Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 181, fig. 12.

Test high; abactinal spines few and scattered; spines present on buccal plates; colour white.

2 specimens, from Porcupine Bank and from 30 miles off Cleggan Head (Ireland), 73½ fms.

These are Mortensen's originals apparently (at least the one from Porcupine Bank), and I quite agree with him that they are worthy of specific rank. It is strange that the Irish Fisheries Board has not found this interesting form more commonly on Porcupine Bank or anywhere else. The *Helga*'s 5 specimens were all taken prior to 1905, and she has not met with it since.

3. PARECHINUS.

Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 108.

Type, *Cidaris angulosa* Leske, 1778. Add. ad Klein, p. 28.

Ocular I (and often ocular V) may be insert; buccal membrane with more or less numerous plates, some of which may bear pedicellariae; a primary tubercle on each ambulacral plate; size small and test rather low.

1. *Parechinus angulosus*.

Cidaris angulosa Leske, 1778. Add. ad Klein, pp. xvii, 28.

Parechinus angulosus Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 108. 1909, Deutsch. Südpolar-Exp. Ech., pl. IX, figs. 8 and 10.

Primary spines fairly stout; coloration diverse, usually red or purple; in young, primaries may be banded.

92 specimens, of which 9 are bare, and 5 are without locality labels. Localities represented are: Tristan da Cunha; St. Helena; Cape of Good Hope; Simon's Bay (*Challenger*); Krysna Beach; St. Sebastian's Bay; Mossel Bay; Algoa Bay; Natal; Durban; Indian Ocean; Mauritius; Port Dalrymple.

This is a very satisfactory series of a characteristically South African species; several of the localities in the above list are surprising.

The 4 specimens from Tristan da Cunha are bare tests, but they seem to be normal adult examples of this species, not hitherto known from that island. The specimens reveal some interesting diversity among themselves, especially in form; one is 46×29 mm., is distinctly pentagonal at ambitus and has only 20 coronal plates; a second is 45×20 mm., is nearly circular and also has 20 coronal plates; the third, 41×24 mm., is nearly circular, but has 25 coronal plates; and the fourth, 40×25 mm., is pentagonal and has 25 coronal plates. The 45 mm. specimen has the primary tubercles on the interambulacra exceptionally conspicuous.

The specimens from St. Helena are very small, only 5–6 mm. in diameter; 2 have white spines, 2 have them red and 3 have them purple. The small size makes it impossible to feel certain that these specimens are *E. angulosus*.

The single specimen labelled Mauritius is the gift of Lady Cole, and seems to have been received in 1842. It is a well-preserved individual, 38 mm. in diameter, with red primaries; probably it came from South Africa.

The largest specimen is from Algoa Bay and measures 48×24 mm.; it is a bare test with 20 coronal plates. The specimens from Mossel Bay and St. Sebastian's Bay are particularly beautiful. Of those from Krysna Beach, 4 are red and 4 are purple.

4. *PSEUDECHINUS*.

Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 106.

Type, *Echinus albocinctus* Hutton, 1882. Cat. Ech. N.Z., p. 12.

Test small but not fragile; ocular I usually insert; every ambulacral plate with a primary tubercle; buccal membrane thin and naked save for the 10 buccal plates.

1. *Pseudechinus albocinctus*.

Echinus albocinctus Hutton, 1882. Cat. Ech. N.Z., p. 12.

Pseudechinus albocinctus Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 106. 1921, N.Z. Ech., pl. VI, figs. 11–15.

Apical system with very few tubercles; ocular I usually exsert; primary spines purple or brownish or reddish, with white tips.

5 specimens, of which 2 are bare; one is without locality label. Localities represented are: New Zealand; Wellington; Otago, Brighton. The specimens from Wellington and the one without locality are labelled *P. magellanicus*, and the one from Brighton is labelled *P. angulosus*.

The specimens from Wellington and 'No loc.' are 30 or 31 mm. in diameter and about 20 mm. high. Ocular I is insert in all; one is conical and more or less deformed.

2. *Pseudechinus magellanicus*.

Echinus magellanicus Philippi, 1857. Arch. f. Naturg., 23 (1), p. 130. Döderlein, 1906. *Valdivia* Ech., pl. XXVII, figs. 9 and 9 a (as *Notechinus magellanicus*).

Apical system with numerous tubercles; ocular I usually insert; primary spines whitish or very light coloured.

136 specimens, of which 3 are without locality. Localities represented are: Patagonian Coast; Southern Chile, St. 304, 45 fms., sand, St. 308, 175 fms., mud; Magellan Strait, St. 311, 245 fms., mud, St. 312, 10–15 fms., mud (*Challenger*). Sandy Point, 9–10 fms., Sandy Point and Cape Porpoise, Patagonia, Tom Bay, 0–30 fms., Cockle Cove, 2–32 fms., Coast of Fuego, Elizabeth Islands, 6 fms., sand, and Trinidad Channel, 30 fms. (*Alert*). Argentina, north-east of Cape Corrientes, 28 fms. (*Hassler*). Near Falkland Islands, St. 315, 5–12 fms., sand and gravel, Marion Island, Prince Edward Island, 50–150 fms., and near Crozet Island, St. 147, 1,600 fms., globigerina ooze (*Challenger*).—Several from Patagonia and 2 from Prince Edward Island were labelled *E. margaritaceus*; 4 from *Challenger* St. 308 were labelled *E. norvegicus*, and 2 without locality were labelled *E. parvituberculatus*.

This is a perplexing series of sea-urchins, and owing to the small size and youth of many of them, the identifications are not always satisfactory. Specimens from Prince Edward Island, 11–22 mm. in diameter, are quite typical save for the colour, which is very light and may be more or less bleached; spines whitish; abactinal system quite green. Specimens from Marion Island, 7–27 mm. in diameter, are also very light coloured. Some of the specimens from Patagonia and some from *Challenger* St. 311 are notable for their very long primary spines. The largest specimen noted is from near the Falklands; it is 35 mm. in diameter, with the actinostome 15 mm.

and the abactinal system only 9 mm. ; oculars I and V are both insert.

Mortensen (1921, N.Z. Ech., p. 163) considers it desirable to maintain a genus *Notechinus* for *P. magellanicus* and its closest allies, but he admits that no line can be drawn between it and *Pseudechinus*. In view of the number of species now known, *Pseudechinus* may be accepted as a group apart from *Parechinus*.

3. *Pseudechinus novaezealandiae*.

Notechinus novaezealandiae Mortensen, 1922. Vid. Medd., 73, p. 153 ; pl. VI, figs. 7-10.

Similar to *P. magellanicus*, but with smaller apical system, more numerous coronal plates and more confluent primary tubercles in ambulacra ; test greenish-grey ; primaries dark green with white tips.

2 specimens, one from Stewart Island, the other labelled 'Antarctic Expedition ; *Echinus angulosus*'.

There is no doubt about the validity of this species ; the specimen from Stewart Island is a very fine and typical one, 32 mm. in diameter.

5. LYTECHINUS.

A. Agassiz, 1863. Bull. M.C.Z., 1, p. 24.

Type, *Cidaris variegata* Leske, 1778. Add. ad Klein, p. 85.

Buccal membrane usually heavily plated ; a primary tubercle on each ambulacral plate ; gill cuts deep ; ocular I, and sometimes V, insert, as a rule.

1. *Lytechinus pictus*.

Psammechinus pictus Verrill, 1867. Trans. Conn. Acad., 1, p. 301.

Lytechinus pictus H. L. Clark, 1912. Mem. M.C.Z., 34, p. 258, pl. CVII, figs. 12-14.

Oculars large, I and V usually insert ; coloration rose purple ; primary spines stout and blunt ; many small abactinal tubercles.

1 specimen labelled '*Toxopneustes semituberculatus*. S. Pacific.'

This is a fairly typical example ; probably it came from the west coast of Mexico.

2. *Lytechinus rufus*.

Salmacis rufa Bell, 1894. Proc. Zool. Soc. London, p. 411, pl. XXVI, figs. 2 and 3.

Lytechinus rufus H. L. Clark, 1912. Mem. M.C.Z., 34, p. 246.

Small, with all oculars exsert ; many primary spines with 2 or 3 red rings.

25 specimens from 7 stations on Macclesfield Bank, 13-44 fms., labelled *Salmacis rufa* or *Temnopleurus* yg.

This lovely species is apparently common enough on Macclesfield Bank; but, save for the specimens secured by the *Siboga* (identified by de Meijere as *Gymnechinus pumilio*), it has not yet been recorded from elsewhere. Mortensen (1904, Dansk. Selsk. Skr. (7), 1, p. 122) has given a good account of this species. Most of the specimens are small, 6–25 mm. in diameter, but the largest, evidently Bell's type, is 32×16 mm. The coloration is very distinctive, and the diversity shown is slight. I agree with Mortensen that *L. rufus* is most nearly related to *L. verruculatus*.

It may be well to call attention to the fact that each of Bell's figures contains a serious error; in fig. 2 there is no ocular plate in ambulacrum III, a condition which cannot occur without distortion of the ambulacrum; in fig. 3 the ambulacral plates are represented as made up of only 2 elements, an equally impossible condition.

3. *Lytechinus semituberculatus*.

Echinus (*Psammechinus*) *semituberculatus* Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 368.

Lytechinus semituberculatus Verrill, 1867. Trans. Conn. Acad., 1, p. 301. (No figure extant.)

Abactinal interambulacral areas very bare, as there are no tubercles between the 2 series of primaries; primary spines very slender, usually bright yellow-green.

16 specimens, of which 8 are bare and 5 have no locality label; 6 are labelled 'Clarion Island' or 'No loc.' The rest are from the Galapagos, Charles Island and Abingdon Island.

The largest of these specimens is 48 mm. in diameter. Two without locality are remarkable for their coloration; the tuberculation is typical, but there is no trace of green in either test or spines, except for a slightly greenish cast in the smaller specimen; the test is wood brown and red brown, and the spines are pale brownish. I have seen similar specimens elsewhere, and I think it possible that the mainland form is distinct from that found at the Galapagos.

4. *Lytechinus variegatus*.

Cidaris variegata Leske, 1778. Add. ad Klein, p. 85.

Lytechinus variegatus A. Agassiz, 1863. Bull. M.C.Z., 1, p. 24. 1872, Rev. Ech., pt. 1, pl. II, figs. 5 and 6, pl. IV a, figs. 4 and 5 (as *Toxopneustes variegatus*).

Abactinal interambulacral plates largely bare; primary spines slender and pointed; oculars I and V usually insert.

43 specimens, of which 16 are without locality labels, 4 are said to be from 'China' and 1 from 'Japan!' Localities represented are: West Indies; Bahamas, Nassau; St. Thomas; Jamaica; Jamaica, Kingston; Barbuda; Rio Janeiro. The specimen from Barbuda was labelled *Echinus gracilis*.

These represent the typical West Indian form of this common species ; there are no examples of the Bermudan subspecies *L. atlanticus* or of the continental *L. carolinus*. One, labelled ' West Indies ', is nearly all white, with green only on the abactinal interambulacra.

4 a. *L. variegatus* var. *pallida* var. nov.

Differing from typical *L. variegatus* chiefly in the peculiar coloration. Test dull greyish or purplish, abactinally quite green when brushed clean ; spines light violet, whitish at base ; on drying the violet fades out almost wholly ; buccal membrane dark purple. Ocular I, fully, and V, slightly, insert in largest specimen (25 mm.). Buccal membrane with few plates outside the ring of buccal plates, but well plated within that circle. Gill cuts deep. Genital pores large. Pedicellariae as in typical *L. variegatus*.

Cape Verde Islands (*Crossland*). ' Porto Praya, dredged in 10 fms. ; light purple, like *E. esculentus*. Abundant in places.'

These four little urchins, labelled *Echinus miliaris*, may represent a distinct species. Compared with specimens of the same size, they look very different from the West Indian form ; but the striking resemblance in the pedicellariae convinces me of their close relationship. In view of this relationship these specimens are probably young, in spite of the large genital pores ; further collecting at Porto Praya may bring to light larger specimens.

The resemblance to *E. esculentus*, referred to by Crossland on his label, is not very obvious, but the resemblance to *E. miliaris* is rather striking ; however, the primaries are more slender and the tuberculation of the test is quite different.

5. *Lytechinus verruculatus*.

Psammechinus verruculatus Lütken, 1864. Vid. Medd., p. 166.

De Loriol, 1883. Mém. Soc. Phys. Hist. Nat. Genève, 28, no. 8, pl. III, figs. 3-3 f (as *Echinus verruculatus*).

Lytechinus verruculatus H. L. Clark, 1912. Mem. M.C.Z., 34, p. 253.

Size small ; test blotched with dull green ; oculars I and V insert ; primary spines with 1-4 faint, narrow rings of greenish or brownish.

4 specimens, 2 bare and without locality labels and 2 from Mauritius.

The largest is a bare test ; it measures 21 × 12 mm.

6. TOXOPNEUSTES.

L. Agassiz, 1841. Mon. Ech., Anat. Echinus, p. ix.

Type, *Echinus pileolus* Lamarck, 1816. Anim. s. Vert., 3, p. 45.

Gill cuts deep and sharply defined; a primary tubercle only on every second, third, or fourth ambulacral plate; pore-pairs in arcs of 3; poriferous area not one-half as wide as interporiferous; size very large.

1. *Toxopneustes chloracanthus*.

H. L. Clark, 1912. Mem. M.C.Z., 34, p. 283. (No figures published.)

No bright violet on test and no blackish ring near tips of spines: no red in coloration, but test and spines are green and white.

3 specimens from Billiton and from Philippine Islands, Masbate. The last is a bare test, labelled *T. pileolus*.

This species was previously known only from Samoa; its occurrence in the Philippines and at Billiton makes me doubtful whether it is a valid species or merely a colour form. At present the line between it and *T. pileolus* seems clear enough, but when large series of specimens are available, intergrades between the two may be found.

2. *Toxopneustes maculatus*.

Echinus maculatus Lamarck, 1816. Anim. s. Vert., 3, p. 46. (No figure published.) Agassiz (1872, Rev. Ech., pt. 1, p. 167; 1873, Rev. Ech., pt. 3, p. 497) considers that Valenciennes' figure 1, plate III, Voyage of the *Venus*, represents this species, but in my opinion the colouring is simply impossible.

Toxopneustes maculatus A. Agassiz, 1872. Rev. Ech., pt. 1, p. 167.

Test with a conspicuous abactinal blotch and an ambital band of bright blue-violet.

6 specimens, all bare tests, and 4 with no locality labels. The others have only the label 'Indian Ocean', which is probably wrong.

This is a very valuable series of this exceedingly rare species, the only definite localities for which are in the north-eastern tropical Pacific Ocean. The present specimens range from 70 to 100 mm. in diameter, with the height considerably less than half the horizontal measurement. In the smallest specimen above, ocular I is insert; in the others, oculars I and V. The coloration is typical in all but one, which is remarkable for having the whole abactinal surface purple and the oral surface lighter purple, palest near mouth; the poriferous areas are, however, nearly white, especially near mouth. The absence of specimens with spines emphasizes the fact that only one individual in normal condition is as

yet known, so far as published records and my observations go; this is a small one from Palmyra Island, in the Bishop Museum, Honolulu.

3. *Toxopneustes pileolus*.

Echinus pileolus Lamarck, 1816. Anim. s. Vert., 3, p. 45. Valenciennes, 1846. Voy. *Venus*: Zooph., pls. VIII and IX.

Toxopneustes pileolus, Agassiz, 1841. Mon. Ech., Hist. Nat. Echinodermes, p. 7.

More or less red in coloration, especially on smaller spines, but general appearance variegated.

32 specimens, of which 6 are bare and 8 are without locality labels. Localities represented are: Muscat; Aden; German East Africa; Mozambique (*Alert*); Mauritius; Seychelles, 4-12 fms., sand and coral (*Alert*); Seychelles, Praslin; Amirante Islands, 35 fms. (*Gardiner*); Andaman Islands; Macclesfield Bank, 30-40 fms.; Philippine Islands, Siquijor; Philippines, Zamboanga (*Challenger*); Japan, Sagami Sea (35° 11' N., 139° 30' E.), 50 fms.

The smallest specimen, from Macclesfield Bank, is 14 mm. in diameter; it shows but few of the big characteristic pedicellariae. A specimen without locality, 23 mm. in diameter, shows that the ambulacra in the young are as in *Lytechinus*, the characteristic *Toxopneustes* condition being attained after the animal is a quarter grown; this little specimen is prettily coloured with deep red and pale grey. One from Zamboanga, only 24 mm. in diameter, has the colours of test and spines equally pronounced; the primary spines are noticeably short, and globiferous pedicellariae are abundant. A bare test without abactinal system, from an unknown locality, is remarkable for its green and pale purple colour, suggestive of *T. chloracanthus*. The largest specimens are from Mauritius and measure 145-150 mm. in diameter.

4. *Toxopneustes roseus*.

Boletia rosea A. Agassiz, 1863. Bull. M.C.Z., 1, p. 24. (No figure extant.)

Toxopneustes roseus Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 136.

Coloration not variegated, but uniformly rosy, purplish or some shade of brown.

3 specimens, from Panama, from Pearl Islands, and from Acapulco.

7. TRIPNEUSTES.

L. Agassiz, 1841. Mon. Ech., Anat. Echinus, p. viii.

Type, *Echinus ventricosus* Lamarck, 1816 = *Cidaris esculenta* Leske, 1778. Add. ad Klein, p. xvii.

Gill cuts deep; poriferous areas very wide, more than half interporiferous; pore-pairs in 3 more or less well separated vertical areas; size very large.

1. *Tripneustes depressus*.

A. Agassiz, 1863. Bull. M.C.Z., 1, p. 24. (No figure extant.)

Buccal membrane with numerous plates; tubercles small but quite uniformly scattered on abactinal side of test.

One specimen from the Gulf of California.

2. *Tripneustes esculentus*.

Udaris esculenta Leske, 1778. Add. ad Klein, p. xvii. A. Agassiz, 1872. Rev. Ech., pt. 2, pl. VI a, figs. 1 and 2 (as *Hipponoe esculenta*).

Tripneustes esculentus Bell, 1879. Proc. Zool. Soc. London, p. 657.

Buccal membrane with few plates; test rather uniformly tuberculated abactinally.

49 specimens, of which 2 are bare and 18 are without locality labels. Localities represented are: Bahamas, New Providence; Turks Island; St. Thomas; Anguilla; Antigua; Grenada; Barbados; West Indies; French Guiana, Cayenne; Fernando Noronha; Ascension; South Atlantic, Trinidad Island.

The specimen from New Providence, 150 mm. in diameter, is the largest and best of the series. A bare test without locality and lacking the whole abactinal system is curiously deformed; it is 93 mm. long, 88 mm. wide, 39 mm. high anteriorly and 30 posteriorly; the long axis passes through an interambulacrum and an ambulacrum which fails by more than 10 mm. to reach the genito-ocular ring.

Eleven specimens from Fernando Noronha, showing that the species is common there; there are two specimens in the Museum of Comparative Zoölogy from the same islet. Rathbun (1879, Trans. Conn. Acad., 5, p. 144) records *T. esculentus* from Brazil and refers to its occurrence at Fernando Noronha. From Ascension there is only a single specimen, apparently the one collected by T. Conry and recorded by Bell (1881, Ann. Mag. Nat. Hist. (5), 8, p. 437) as *T. angulosus*. From Trinidad Island there is a young specimen 35 mm. in diameter, but evidently of this species. Mortensen (1907, Ingolf Ech., pt. 2, p. 184) records *T. esculentus* from West Africa.

3. *Tripneustes gratilla*.

Echinus gratilla Linné, 1758. Sys. Nat., ed. x, p. 664.

Tripneustes gratilla Lovén, 1887. Bih. Svensk. Vet.-Akad. Handl., 13 (4), No. 5, p. 77. H. L. Clark, 1921. Carnegie Inst. Mar. Biol. Papers, 10, pl. XVII, fig. 6.

Buccal membrane with rather numerous plates; abactinal surface, especially in interambulacra, rather sparsely tuberculated.

56 specimens, of which 2 are bare and 8 are without locality labels. Localities represented are: Red Sea; Aden; Gulf of Suez; Zanzibar (*Crossland*); German East Africa; Dar-

es-Salaam ; Mozambique ; Cape of Good Hope ; Mauritius ; Rodriguez ; Seychelles, Praslin (*Gardiner*) ; Borneo, south-eastern coast ; Philippine Islands ; Philippines, Masbate ; Philippines, Zamboanga ; Celebes, Badjou ; New Guinea ; New Guinea, Hoods Lagoon ; Australia ; Torres Strait, Reef of Attagor ; Reef of Oomaga ; New South Wales, Port Jackson, 6-15 fms. (*Challenger*) ; Fiji, Levuka (*Alert*) ; Rotuma (*Gardiner*) ; Raoul (*Herald*).

The diversity in form and colour is very marked. The most notable specimens are those from Mauritius, several of which are curiously depressed, even markedly concave abactinally. In one, 60 mm. in diameter, the vertical height at the sides is 21 mm., although at the abactinal system it is only 10 ! Others are 76 mm. in diameter and 27 at abactinal system, and 92 mm. by 36. A curious specimen, 72 mm. in diameter, has the ambulacra abactinally so depressed below the interambulacra and the abactinal system, that they form regular pouches near the ocular plates ; the vertical diameter through the periproct is 24 mm., but in these pouches it is only about 20. It would be interesting to know the cause of this depression. A bare specimen (112 mm.) without locality and lacking the whole abactinal system shows an opposite influence at work, for in one of its ambulacra is a swelling about 50 mm. long, 20 mm. wide and 10 mm. high. The specimen from Aden is remarkable for the height of its test, for though it is only 85 mm. in diameter it is 57 mm. high. The single bare test from the Red Sea is 67 mm. in diameter, but has oculars I, V, II, insert ; the test is prettily marked with dull pink, a very unusual coloration. The specimen labelled Cape of Good Hope was received in 1840, and it is probable that it came from Mozambique or perhaps Natal, as there is no reliable record of this species from south of Durban. The 4 specimens from Zanzibar are 14-16 mm. in diameter ; they have ocular I insert and V either exsert or just barely in contact with the periproct ; they are white save for the interambulacral areas abactinally, which are dusky. The specimen from Levuka is similar in colour, even the pedicels being white ; it is 25 mm. in diameter.

Bare tests of *T. gratilla* can be distinguished from those of *T. esculentus*, usually at a glance, by the noticeably barer abactinal interradiar areas ; even when young, *T. esculentus* has many more tubercles. White specimens of *T. gratilla* are not very common, except as less than half-grown individuals. With the spines on, they are not easily distinguished from *T. esculentus* of the same size ; in general, however, the spines are more slender and more numerous.

8. NUDECHINUS.

H. L. Clark, 1912. Mem. M.C.Z., 34, p. 276.

Type, *Nudechinus scotiopremnus* H. L. Clark, 1912. Mem. M.C.Z., 34, p. 277.

Very similar to *Pseudechinus*, but valves of globiferous pedicellariae with a big tooth at tip and no lateral teeth; oculars I and V commonly insert.

1. *Nudechinus darnleyensis*.

Echinus darnleyensis Tenison-Woods, 1878. Proc. Linn. Soc. N.S.W., 2, p. 165. (No figures published.)

Nudechinus darnleyensis H. L. Clark, 1912. Mem. M.C.Z., 34, p. 277.

Primary spines not banded; test and small spines whitish or yellowish, more or less dusky dorsally; primaries darkest at base, light at tip; secondary spines not swollen at tip.

8 specimens from the *Alert* collection: Torres Strait, Prince of Wales Channel, 7-9 fms., sand; Thursday Island, 3-6 fms., sand and coral.

These are recorded in the *Alert* Report in part as *E. darnleyensis*, but mostly as *E. angulosus*; 6 were labelled *E. angulosus* and 2 *E. darnleyensis*. They measure $16 \times 8\frac{1}{2}$ mm., $17\frac{1}{2} \times 9\frac{1}{2}$, 18×9 , 22×11 , 22×12 , 23×12 , 26×15 and 27×12 mm., the height thus ranging from 44 to 58 per cent. of the diameter. In 3 specimens all the oculars are exsert, although in one of them ocular I is nearly in; in 1 specimen, ocular I alone is insert; in 4 (including the three largest), oculars I and V are insert, but in 2 of these ocular I is barely in. Ocular II is far excluded in all but the 26 mm. specimen, in which it is only barely exsert.

This diversity regarding the ocular plates helps to explain a disagreement between Bell and Mortensen. The latter wrote (1904, Dansk. Selsk. Skr. (7), 1, p. 115): 'In the *Ingolf* Echinoidea (p. 110) I have written of *Gymnech. darnleyensis* that the ocular plates are not excluded from the periproct according to information received from Prof. Bell in a letter to me. . . . Now I must state, after having re-examined the specimens of *G. darnleyensis* in the British Museum during my visit there last summer, that all the ocular plates are indeed excluded from the periproct.'

In general the colour may be described thus: Test whitish or yellowish, more or less dusky abactinally or even pale brown, with a greenish or a violet tinge near the abactinal system. Spines white with brownish or violet bases, or brownish or violet with white tips; usually the oral spines show more colour than those above the ambitus. There is great diversity in the amount and the brightness of the colour on

the spines, but they show no signs of banding. The smaller specimens are nearest to a white and bright violet colouring, and the larger are more dusky and subdued.

2. *Nudechinus rubripunctatus* sp. nov. PLATE VII, figs. 1 and 2.

Test 20 mm. in diameter and 11.5 mm. high. Coronal plates 16 in a column; interambulacra 6.5 mm. wide; each coronal plate carries 1 primary tubercle (at ambitus, below ambitus 2) and half a dozen secondaries chiefly at the outer end; above ambitus there is a fairly distinct but very narrow bare interambulacral area. Ambulacra 6 mm. wide; ambulacral plates about 24 in a column; each plate with 1 primary, 1 secondary and a few miliary tubercles; poriferous areas wide, the 2 together equal to the interporiferous area. Abactinal system 4 mm. across, of which the periproct occupies 2. Ocular I insert. Anus excentric. No distinct suranal plate is evident, but there are 2 plates of about equal size, considerably larger than the others, occupying its normal position. Peristome 6.5 mm. across, covered with a thin perfectly naked membrane. Buccal plates white, distinct, each with a tube foot; the 2 plates of a pair are close together, but the pairs are far apart, and are placed far from the mouth; in each pair one plate is distinctly larger than the other. It is noteworthy, however, that the arrangement of these plates exactly reverses 'Lovén's law', for here the large plates are I b, II b, III a, IV b and V a. Primary spines rather blunt, 4-5 mm. long.

Pedicellariae abundant. Globiferous pedicellariae with big, dark brown glands on valves, which terminate in a single end tooth, as in *N. scotiopremnus*. Ophicephalous pedicellariae not peculiar, the valves essentially as in *Gymnechinus pulchellus*. I failed to find any tridentate or triphyllous pedicellariae.

Coloration pretty and characteristic; test variegated red-dish and white, with conspicuous red blotches at ambitus and above; small spines more or less white, but basal half may be red or there may be 1 or more red bands; primaries whitish with 3-5 very distinct bright red bands. In alcoholic specimens the reds are a very bright brick red or even approach scarlet, not at all rosy; in dry specimens the reds are duller, but show no tendency towards rose.

Amirante Islands, 25-80 fms. (*Gardiner*), 2 specimens.

This very handsome little urchin is well distinguished by its coloration, and by the arrangement of the periproctal and buccal plates; but it may be nearer to *N. gravieri* Koehler than the description would lead one to suppose. The absence of any green and the peculiarly bright shade of the red mark-

ings on the test make me feel very sure that these specimens cannot be referred to Koehler's species.

3. *Nudechinus scotiopremnus*.

H. L. Clark, 1912. Mem. M.C.Z., 34, p. 277, pl. XCVII, figs. 4-6.

Test with more or less green; spines white, green or brown at the very base.

20 specimens, of which 2 are bare and 9 have no locality labels. Localities represented are: Suez; Gulf of Suez; Red Sea; 'Swan River, J. B. Jukes'. Three from Suez were labelled *Echinus angulosus*, and a bare test from the Red Sea, *Toxopneustes pileolus*.

Three specimens in the Museum of Comparative Zoölogy are the only others of this species recorded hitherto. The 3 specimens labelled 'Swan River' are typical examples: it is unlikely that they came from West Australia!

The diameter ranges from 5 to 21 mm.; in the smallest specimens the bases of the primary spines are more or less violet, but this becomes dull brown or generally dark green in the adults. When the distal half of the spine is pure white and the basal part dark green, the coloration is rather striking.

The larger specimens have oculars I and V both insert, as they should be in *Nudechinus*, but the smaller specimens show considerable diversity, with all exsert or either I or V more or less insert.

9. GYMNECHINUS.

Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 115.

Type, *Echinus robillardi* de Loriol, 1883. Mém. Soc. Phys. Hist. Nat. Genève, 28, no. 8, p. 23.

Test small, flat; periproct excentric at right, with oculars I and II insert or nearly so.

1. *Gymnechinus abnormalis* sp. nov. PLATE VII, figs. 3 and 4.

Test 8 mm. in diameter by 3 mm. high, quite flat. Interambulacra about 3 mm. wide. Coronal plates 9 or 10 in a column, each plate with a moderately large primary tubercle, and at ambitus about 4 secondaries; above the midzone secondary tubercles are infrequent. Ambulacra about 2 mm. wide, with 10 or 11 plates in each column; each plate with a primary and 1-3 secondary tubercles. Abactinal system 3.5 mm. across, of which the periproct occupies less than half. Ocular I insert and ocular II nearly so, but ocular V fully excluded, like III and IV. Anal opening very close to genital 1. Suranal plate distinct, but not much if any larger than some other plates on the periproct; all periproctal plates very thin. No tubercles (or only 1 or 2 small ones) on any part of abactinal system. Actinostome 4.5 mm.

across, covered by a thin, naked membrane, with 10 small, equal buccal plates, each with a pedicel. Primary spines stout, 3-3.5 mm. long, rather blunt, with very distinct longitudinal striations. Pedicellariae not abundant; only ophi-cephalous were found, and they are not in any way distinctive. Auricles not examined, but in view of the small size and general character of the test they are probably not united into arches.

Colour very pale reddish-purple or (orally) purplish-white, including primary spines; pedicels and muscles dark brown. In alcohol the primaries are more nearly white, and pedicels and muscles are light purplish-brown.

Carcajos Carados, 30 fms. (*Gardiner*), 2 specimens.

These little sea-urchins are perplexing because they do not fully conform to the definition of *Gymnechinus*. Probably they are immature, so that the fact that ocular II does not quite reach the periproct may be overlooked, since ocular V is fully excluded, and the position of the anus is exactly where it should be. I have little doubt that in adults ocular II will be found fully insert. The distinctive characters of this species are the colour, the short, stout, striated primary spines, the very thin periproctal plates, and the absence of tubercles on the whole abactinal system.

2. *Gymnechinus robillardi*.

Echinus robillardi de Loriol, 1883. Mém. Soc. Phys. et Hist. Nat. Genève, 28, no. 8, p. 23, pl. III, figs. 1-2 b.

Gymnechinus robillardi Mortensen, 1903. *Ingolf* Ech., pt. 1, p. 115.

Spines white; suranal small without a tubercle, in contact with only 2 genitals; gill slits shallow.

9 specimens from Mauritius, Ceylon, and Gulf of Manaar (*Thurston*). The specimens from Ceylon were labelled *Echinus angulosus*.

This series of this very interesting sea-urchin shows it to be common in the vicinity of Ceylon. The largest specimen is 30 mm. in diameter. In a specimen from Ceylon, 23 mm. in diameter, the auricles are well separated, but in one, 27 mm. in diameter, they are fully united; evidently this condition is attained with full maturity.

3. *Gymnechinus versicolor*.

Mortensen, 1904. Dansk. Selsk. Skr. (7), 1, p. 116. (No figure published, except of spicules and pedicellariae.)

Secondary tubercles in interambulacra not arranged in definite horizontal series; primary spines with 1-3 red bands.

9 specimens from 4 stations on Macclesfield Bank, 35-50 fms. Several were labelled *Temnopleurus reynaudi*.

Three of these lovely little urchins are Mortensen's types. One of the specimens shows no trace of green in the coloration.

Family 3. STRONGYLOCENTROTIDAE, Gregory.

Ambitus circular; no pits or sculpturing on the coronal plates; ambulacral plates compound, usually with 4 or more elements (rarely 3).

The 10 genera here included in this family are all represented in the British Museum, and about two-thirds of the known species are in the collection. Most of the genera are well defined, and there is little room for discussion as to their limits. Possibly *Heliocidaris* may need to be divided, for the Australian *H. tuberculata* is superficially very different from *H. crassispina*; but so long as *Strongylocentrotus franciscanus* remains congeneric with *S. pulcherrimus*, *H. tuberculata* and *H. crassispina* may be permitted to bear the same generic name. Mortensen's genus *Pseudocentrotus* may prove to be a natural group, but until at least a second species is found. *P. depressus* may well be left in *Strongylocentrotus*.

1. ECHINOSTREPHUS.

A. Agassiz, 1863. Bull. M.C.Z., 1, p. 20.

Type, *Echinostrephus aciculatus* A. Agassiz, 1863. Bull. M.C.Z., 1, p. 20.

Ambitus above equator; oculars all exsert; longest primary spines on abactinal surface; ambulacral plates with 3 or 4 pore-pairs.

1. *Echinostrephus molare*.

Echinus molare de Blainville, 1825. Diet. Sci. Nat., 37, p. 88.

De Lorient, 1883. Mém. Soc. Phys. Hist. Nat. Genève, 28, no. 8, pl. IV, figs. 2-2 c.

Echinostrephus molare A. Agassiz, 1872. Rev. Ech., pt. 1, p. 119.

Pore-pairs in arcs of 3; genital and ocular plates with no tubercles except on outer margin.

13 specimens, of which 3 are bare and without locality labels. Localities represented are Zanzibar; Mauritius; Glorioso Island, 7-10 fms., sand and coral (*Alert*); Maldives, Minikoi; Solomon Islands; Fiji. There is also a specimen labelled 'Cape of Good Hope', but it dates back to 1840, and probably did not come from South Africa.

None of these is large and several are very young. One from Fiji is only 6 mm. in diameter, with primary spines 7-8 mm. long.

2. PSEUDOBOLETIA.

Troschel, 1869. Sitz. Niederrh. Gesel. Bonn, p. 96.

Type, *Pseudoboletia stenostoma* Troschel, 1869. *Toropneustes indianus* Michelin, 1862. Ech. et Stel.; Annexe A. in Maillard's Notes sur Bourbon, p. 5.

Test low, thin, with ambitus below equator ; gill cuts deep ; buccal plates carry spines.

1. *Pseudoboletia atlantica*.

H. L. Clark, 1912. Mem. M.C.Z., **34**, p. 344. Koehler, 1908. Trans. Roy. Soc. Edinburgh, **46**, pl. XV, figs. 139-142, pl. XVI, fig. 165 (as *P. maculata*).

Pore-pairs in arcs of 5 ; actinal primary spines more or less marked with green.

One specimen from St. Helena (*Alexander*).

This is a fine specimen of a little known species. The diameter is 70 mm. and the height only 32 ; the actinostome is 26 mm. across, but the abactinal system is surprisingly small, only 11 mm. The pore-pairs are rather large, and are so grouped that 3 pairs stand near the outer margin of the plate in a nearly vertical series, and the other 2 are much further in and are more nearly side by side ; the third, fourth, and fifth pairs thus form a very oblique series. Oculars I and V are broadly insert. Oral spines show little or no trace of green, but as the colours are dull and, orally at least, bleached, not much significance can be attached to this.

The only specimens of this species hitherto known were taken off Ascension, and were recorded by Koehler (1908, Trans. Roy. Soc. Edinburgh, **46**, p. 641) as *P. maculata*.

2. *Pseudoboletia indiana*.

Toxopneustes indianus Michelin, 1862. Ech. et Stel. Année A, in Maillard's Notes sur Bourbon, p. 5.

Pseudoboletia indiana A. Agassiz, 1872. Rev. Ech., pt. 1, p. 153. De Loriol, 1883. Mém. Soc. Phys. Hist. Nat. Genève, **28**, no. 8, pl. III, figs. 4-4 f.

Pore-pairs in arcs of 4 ; large and low ; test not blotched with darker ; primary spines not banded ; dull pink or whitish, short and thick.

10 specimens, of which 1 is without a locality label, and the others are from Mauritius and from Philippine Islands, Zamboanga (*Challenger*).

The specimens from Mauritius are typical, but that from Zamboanga should perhaps be referred to *P. maculata*. The specimen without locality was labelled *Arbacia* ; no spines are evident on the buccal plates, and the gill cuts are not conspicuous, but there is no doubt of its identity.

3. *Pseudoboletia maculata*.

Troschel, 1869. Verhandl. Nat. Ver. Rheinl. und Westph., p. 96. (No figure extant. Bell's (1884, Ann. Mag. Nat. Hist. (5), **13**, p. 110) statement that figs. 8 and 9, pl. V a, of the ' Revision ' represent this form is a mistake.)

Pore-pairs in arcs of 4 : test conspicuously blotched with darker ; primary spines more slender.

12 specimens, of which 2 are bare. Localities represented are : India, Madras ; Philippine Islands ; Philippines, Masbate ; Philippines, Zamboanga (*Challenger*) ; Macclesfield Bank, 39 fms. A single bare test is labelled ' Port Lincoln, Torres Strait ', but so far as I can discover there is no such place.

The validity of *P. maculata* is doubtful ; probably it is a variety of *P. indiana*. The 2 specimens from Madras are unquestionably *P. maculata* in the presence of spots, but otherwise are *P. indiana*. The characters of the buccal plates are worthless, for there is considerable diversity in their size and position, and no correlation with colour. On the other hand, the dull pink, short, rather stout spines of *P. indiana* seem to be quite distinct from the more slender spines of *P. maculata* : both forms occur at Zamboanga. The specimens from Macclesfield Bank are very fine examples, although the dark blotches are small and not conspicuous ; one is 75 mm. in diameter, and the other is 65.

3. PARACENTROTUS.

Mortensen, 1903. *Ingolf Ech.*, pt. 1, p. 124.

Type, *Echinus lividus* Lamarck, 1816. *Anim. s. Vert.*, **3**, p. 50.

Pore-pairs in arcs of 4 or 5 ; all oculars exsert or rarely 1 is insert ; primary spines moderately long and slender : buccal membrane with scattered plates.

1. *Paracentrotus agulhensis*.

Döderlein, 1905. *Zool. Anz.*, **28**, p. 623. 1906, *Valdivia Ech.*, pl. XXVII, figs. 1-4.

Pore-pairs 4 (or only 3) in an arc ; unicolour, but not dark.

3 specimens from Cape of Good Hope St. 145, off Cape St. Blaize, 35 fms., and St. 200, off Cape Point. 660-700 fms., labelled *Echinus gilchristi*.

2. *Paracentrotus lividus*.

Echinus lividus Lamarck, 1816. *Anim. s. Vert.*, **3**, p. 50.

Paracentrotus lividus Mortensen, 1903. *Ingolf Ech.*, pt. 1, p. 124.

A. Agassiz, 1873. *Rev. Ech.*, pt. 3, pl. V b, fig. 3 (as *Strongylocentrotus lividus*).

Pore-pairs 5, as a rule ; colours diverse but dark, usually green or purple.

171 specimens, of which 1 is bare and 23 are without locality. The bare test was labelled ' West Australia ', and 7 specimens were labelled ' *Strongylocentrotus drobachiensis*, Greenland, Valorous, 1875 '. Localities represented are : Ireland ;

Ireland, Lough Foyle; England, Ilfracombe; Jersey; Mediterranean Sea; Palestine, Nahr Rubin; Greece, Salamis; Italy, Naples; France, Hyeres; Bay of Marseilles; Nice; Balearic Islands, Mahon; Coast of Portugal; Spain, Cape Finisterre; Tunis; Algiers; Tangiers; Madeira; Madeira, Funchal; the Salvages, Great Piton. The specimens from Lough Foyle were labelled *Echinus miliaris*, some from the Mediterranean, *Sphaerechinus granularis*, and some without locality, *Echinus saxatilis* or *Strongylocentrotus dröbachiensis*.

The best specimens are from Ireland, especially from Lough Foyle. There are 26 specimens labelled 'Ireland', which range in size from 9×4 mm. to 68×37 ; 6 of the small ones are light green, but most of the others, including smallest and largest, are purple. There seems to be no correlation of the light (and often bright) green colour with size, age, sex or locality.

4. EVECHINUS.

Verrill, 1871. Trans. Conn. Acad., 1, p. 583.

Type, *Echinus chloroticus* Valenciennes, 1846. Voy. *Vénus*: Zooph., pl. VII, fig. 2.

Poriferous areas very broad; pore-pairs at ambitus in 3 distinct vertical series; a primary tubercle on only every second, third, or fourth ambulacral plate; gill cuts shallow.

1. *Evechinus chloroticus*.

Echinus chloroticus Valenciennes, 1846. Voy. *Vénus*: Zoophytes, pl. VII, fig. 2.

Evechinus chloroticus Verrill, 1871. Trans. Conn. Acad., 1, p. 583.
A. Agassiz, 1873. Rev. Ech., pt. 3, pl. IV b, fig. 7.

Test solid, large, coarsely tuberculated; primary spines green, in young specimens banded with white.

35 specimens, of which 8 are without locality labels. Localities represented are: New Zealand; New Zealand, Nelson, Golden Bay; Otago; Tasmania; Fiji, Kandavu Reef (*Challenger*); Philippine Islands, Mindoro, 6–10 fms., coarse mud. The localities outside New Zealand are improbable, especially Mindoro.

The most interesting of these specimens are the types of Bell's *E. rarituberculatus*. The larger is 45×21 mm. and the smaller is nearly as large. Owing to the small number of coronal plates, the wide spacing of the primary spines, and the small size of all the tubercles, these individuals look very unlike normal *E. chloroticus*. The ground colour of the test is very dark, almost a black-green. There are only 14 interambulacral and 18 ambulacral tubercles in each vertical series, although in a typical *E. chloroticus*, 48 mm. in diameter, these figures are 18 and 22. These specimens seem to represent

a form, which if it is at all frequent, might be regarded as a variety of *E. chloroticus*. The specimen said to be from Mindoro has the tuberculation quite like this form, but the colour is that of a typical *chloroticus*.

Mortensen (1921, Vid. Medd., **73**, p. 173) notes a specimen 124 mm. in diameter which he suggests 'may be a record size'. One in the British Museum, from New Zealand, is 140 mm. in diameter and 68 mm. high.

The 3 specimens said to be from Tasmania are young, 18-36 mm. in diameter.

5. LOXECHINUS.

Desor, 1856. Syn. Ech. Foss., p. 136.

Type, *Echinus albus* Molina, 1782. Saggio Stor. Nat. Chile, p. 175.

Test stout, all oculars usually exsert but I and V often insert; primary spines short, green; pore-pairs in arcs of 7-10.

1. *Loxechinus albus*.

Echinus albus Molina, 1782. Saggio Stor. Nat. Chile, p. 175. H. L. Clark, 1910. Bull. M.C.Z., **52**, pl. XII, fig. 1 (as *Strongylocentrotus albus*).

Loxechinus albus Desor, 1856. Syn. Ech. Foss., p. 136.

Test brownish or greenish, heavily tuberculated; pore-pairs commonly in arcs of 9.

16 specimens, of which 3 are bare and without locality. Localities represented are: Chile; Chile, Port Otway; Chile, Gulf of Las Peñas, St. 304, 45 fms., sand (*Challenger*); Straits of Magellan; and Straits of Magellan, Tom Bay, 0-30 fms. (*Alert*). The *Challenger* specimen and one other from Chile were labelled *St. gibbosus*. The *Alert* specimens were labelled *St. bullatus*.

Examination of the types of *L. bullatus* Bell leaves me in doubt as to the status of that form; probably the specimens thus called fall well within the limits of variation of *L. albus*. The specimen from Chile, labelled *St. gibbosus*, undoubtedly was so called because of its badly distorted periproct; it is 95 mm. in diameter, and oculars III, IV and V are insert, while I and II are exsert; whether the distortion of the periproct is due to the parasitic crab that so generally occupies the periproct of *St. gibbosus* could not be ascertained.

A very peculiar bare test, labelled '*Loxechinus bullatus*', 'North Sydney', has the tuberculation even more sparse than in *L. bullatus*; there are usually 9 pore-pairs to an arc, but evidences of resorption between the pores suggest pathological conditions.

6. CAENOCENTROTUS.

H. L. Clark, 1912. Mem. M.C.Z., 34, p. 348.

Type, *Echinus (Toxopneustes) gibbosus* Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 367.

Test not very stout; buccal membrane with scattered plates; oculars V and IV insert, often III also, sometimes II and occasionally all.

1. *Caenocentrotus gibbosus*.

Echinus (Toxopneustes) gibbosus Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 367.

Caenocentrotus gibbosus H. L. Clark, 1912. Mem. M.C.Z., 34, p. 348. H. L. Clark, 1910. Bull. M.C.Z., 52, pl. XII, fig. 2 (as *Strongylocentrotus gibbosus*).

Test low, with big abactinal system almost always distorted by a parasitic crab; spines green.

15 specimens, of which 10 are bare and 12 are without locality. The only locality certainly represented is Peru, Callao; but one example has the label ' ? Clarion Island '.

The largest specimen is 67 mm. long, 63 wide and 30 high on one side, 34 on the other; the test is obviously deformed; as the abactinal system is wanting, the path of the long axis could not be determined, but it is through an ambulacrum and an interambulacrum. There are 7 young individuals, 18-24 mm. in diameter, in all of which oculars V and IV are insert; in 2, ocular III is very nearly insert also, and in one of the smallest oculars III and I are both insert.

7. PACHYCENTROTUS.

H. L. Clark, 1912. Mem. M.C.Z., 34, p. 349.

Type, *Sphaerechinus australiae* A. Agassiz, 1872. Bull. M.C.Z., 3, p. 55.

Test very stout, thickly covered with tubercles; oculars I and V insert, often II or IV also; buccal membrane more or less heavily plated.

1. *Pachycentrotus australiae*.

Sphaerechinus australiae A. Agassiz, 1872. Bull. M.C.Z., 3, p. 55.

Pachycentrotus australiae H. L. Clark, 1912. Mem. M.C.Z., 34, p. 349, pl. XCVIII, figs. 5-8.

Test light violet, with tubercles somewhat green; spines variegated, light violet, green and white.

4 specimens, of which 2 are bare. Localities represented are: Victoria, Port Philip; Bass Straits, *Challenger* St. 162, 38-40 fms., sand; Tasmania.

The *Challenger* specimen is only 7 × 4.5 mm., but the one from Port Philip is 22 × 12 and the Tasmanian specimens are

32 × 19 and 38 × 25 respectively. The smallest and largest specimens are thus alike in having the height of the test very nearly two-thirds of its diameter. The Port Philip specimen is probably not quite adult; ocular V is not fully insert as it is in the larger specimens. Apparently this is a rare species, confined to south-eastern Australia. It was not taken by either the *Thetis* or the *Endeavour*. The supposed records from New Zealand and Mauritius are quite unreliable.

8. HELIOCIDARIS.

Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 371.

Type, *Echinus omalostoma* Valenciennes, 1846 = *Echinus tuberculatus* Lamarck, 1816. Anim. s. Vert., 3, p. 50.

Test very stout; pore-pairs in arcs of 7–10; primary spines stout; oculars I and V insert.

1. *Heliocidaris armigera*.

Strongylocentrotus armiger A. Agassiz, 1872. Bull. M.C.Z., 3, p. 55.

1873, Rev. Ech., pt. 3, pl. V a, fig. 1.

Heliocidaris armigera H. L. Clark, 1912. Mem. M.C.Z., 34, p. 350.

Test low; primary spines very short and stout; pore-pairs 7 or 8 in an arc.

11 specimens, of which 1 is bare and 2 are without locality labels. Localities represented are: 'New Holland'; West Australia; Swan River.

The bare test from 'New Holland' was probably assigned to this species because of the large tubercles. The 6 Swan River specimens range from 24 × 12 mm. to 68 × 30; the small ones have the spines, especially the actinal ones, quite green, but in the larger specimens the green tint has disappeared. The validity of *H. armigera* is doubtful.

2. *Heliocidaris crassispina*.

Toxocidaris crassispina A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 356.

Heliocidaris crassispina H. L. Clark, 1912. Mem. M.C.Z., 34, p. 350. (No figures extant.)

Diameter of peristome about one-third that of test; pore-pairs in arcs of 7 or 8; colour very dark (blackish, purplish, or brownish); spines rather slender (in spite of the name!).

18 specimens, of which 6 are bare, and 5 are without locality. Localities represented are: Japan; Japan, Sagami Bay (34° 59' N. × 139° 50' E.); China; China, Swatow. Most of the specimens are labelled *St. tuberculatus*.

The two from Sagami Bay are about 22 × 9 mm.; primaries rather bright red violet, dull at base; small spines green, often violet at tip. Larger specimens become uniformly dark

coloured, usually a very deep red-purple, which seems to be a very constant character for the species.

3. *Heliocidaris erythrogramma*.

Echinus erythrogrammus Valenciennes, 1846. Voy. *Vénus*: Zoophytes, pl. VII, fig. 1.

Heliocidaris erythrogramma Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 371.

Pore-pairs mostly in arcs of 7; colours diverse but not very dark, violet, reddish or greenish.

98 specimens, of which 5 are bare and 13 are without locality labels. Localities represented are: 'New Holland'; New South Wales, Port Stephens; Sydney; Port Jackson; Bondi Head; Bass Strait; *Challenger* St. 162, Bass Strait, 38-40 fms., sand; 'Van Diemen's Land'; Tasmania; Port Dalrymple; Victoria, Port Philip Heads; Warrnambool; South Australia; Adelaide; West Australia. The labels New Zealand, Torres Straits, and Simon's Bay, Cape of Good Hope, also occur, but are not worthy of credence. Labels reading 'Antarctic Exp. 1844' and 'Jukes, 1846', obviously indicate Australian material. The specimen from *Challenger* St. 162 was labelled *Sphaerechinus australiae*, the one from 'New Zealand', *Stomopneustes variolaris*. Many specimens were labelled *St. tuberculatus*, and 2 from Port Jackson were marked *St. armigera*.

This is a good representative series (11-80 mm. in diameter) of the commonest Australian sea-urchin, which ranges from Port Stephens, N.S.W., along the whole southern coast of the continent and up the west coast to the Abrolhos Islands. There is great individual diversity in form and colour, and I have no faith in the validity of var. *meridionalis* Döderlein. One of the specimens from South Australia is peculiar in that the primary tubercles (and spines, of course) are relatively few; miliaries are also infrequent and the primary spines are very slender. Of 6 specimens from Port Philip Heads, 4 are parasitized abactinally by some small brown gastropod molluscs; the tests are very flat (50 × 16-19 mm.) and the primary spines are very slender; presumably these peculiarities are due to the parasites.

4. *Heliocidaris tuberculata*.

Echinus tuberculatus Lamarck, 1816. Anim. s. Vert., 3, p. 50.

A. Agassiz, 1873. Rev. Ech., pt. 3, pl. V b, figs. 4 and 5 (young; as *Strongylocentrotus tuberculatus*).

Heliocidaris tuberculata H. L. Clark, 1912. Mem. M.C.Z., 34, p. 282.

Pore-pairs in arcs of 9 or 10; colours rather light, brown or greenish.

33 specimens from Raoul Island; Kermadec Islands; Sydney; Victoria, Port Philip Heads. The specimens from Raoul and a bare test from Sydney were labelled '*St. erythrogrammus*'.

The Raoul and Kermadec specimens are typical and very fine. The 18 specimens from Port Philip Heads range from 25 to 75 mm. in diameter and show considerable diversity in form; several are flattened to an unusual degree; one, 47 mm. in diameter, is only 15 mm. high. The coloration also varies, some being predominantly green and some purple.

9. STRONGYLOCENTROTUS.

Brandt, 1835. Prodr. descr. Anim., p. 263.

Type, *Strongylocentrotus chlorocentrotus* Brandt, 1835 = *Echinus dröbachiensis* O. F. Müller, 1776. Prodr. Zool. Dan., p. 235.

Pore-pairs 4-10, but usually not more than 7; value of globiferous pedicellariae with a powerful end tooth but no lateral teeth.

1. *Strongylocentrotus droebachiensis*.

Echinus dröbachiensis O. F. Müller, 1776. Prodr. Zool. Dan., p. 235.

Strongylocentrotus droebachiensis A. Agassiz, 1872. Rev. Ech., pt. 1, p. 162; pl. IV a, figs. 2, 3, and 6.

Very diverse in form, colour and length of spines; pore-pairs 6 or 7, rarely 8; test not thin and fragile; coronal plates numerous; gill-cuts shallow.

301 specimens, of which 7 are bare tests and 15 have no locality labels. Localities represented are: Kara Sea; Franz Josef Land; Spitzbergen; Finmark, Vadsø; East Finmark, Lang Fjord; Varanger Fjord; Norway; Trondhjem Fjord; Gravefjord; Kattegatt; Denmark; North Sea; Shetland Islands, Sandwich Bay; *Porcupine* St. 82, North of Cape Wrath, 312 fms.; St. 65, north-west of Shetland, 345 fms.; Greenland; Cape Farewell; Cape Napoleon, (*Sladen*); Hayes Point, 35 fms. (*Sladen*); Winter Quarters 1875-6, 15-20 fms.; Davis Strait; Franklin Pierce Bay; Regent Inlet; North America; Labrador; Le Have Bank, 75 fms. (*Challenger*); Maine, Eastport; Massachusetts, off Cape Cod, 20-40 fms.; Massachusetts Bay; Rhode Island, off Newport; British Columbia, Skeena River, Inverness; Queen Charlotte Islands; Vancouver Island; California.

The specimen labelled California dates back to 1843, and probably came from some point on the British Columbian or Alaskan coast; it is notable for its pale lavender, almost white, spines. There are 7 bare tests from Greenland which show some interesting features; 2 lack the genito-ocular ring, but of the other 5 only 1 has oculars I and V insert; the other 4, including the largest, 78 × 32 mm., have all oculars exert. This is most extraordinary as Jackson (1912. Phyl. Ech., p. 143) found only a single adult individual of which this was true, in the thousands of specimens he examined; but he had

no material from Greenland. He noted, however, that specimens from Labrador, Iceland, and the Faroe Islands tend to be progressive variants; but these Greenland specimens are remarkably arrested variants.

2. *Strongylocentrotus franciscanus*.

Toxocidaris franciscana A. Agassiz, 1863. Bull. M.C.Z., 1, p. 22.

Strongylocentrotus franciscanus A. Agassiz, 1872. Rev. Ech., pt. 1, p. 163; 1873, pt. 3, pl. V b, figs. 1 and 2.

Very large; primary spines long and stout; pore-pairs in arcs of 9 or 10.

3 specimens, of which 1 is bare. They are from 'Columbia River'; California, Santa Cruz; 'La Paz'.

There is probably a mistake about the 'La Paz' specimen, as it is highly improbable that this species occurs so far south. The specimen may have been secured at La Paz from a sailor or dealer.

3. *Strongylocentrotus intermedius*.

Psammechinus intermedius A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 357.

Strongylocentrotus intermedius A. Agassiz, 1872. Rev. Ech., pt. 1, p. 164. (No figure extant.)

Pore-pairs typically 5, tending to form 3 vertical series; poriferous areas very wide; primary spines greenish, reddish, or both.

2 specimens from Japan, Yezo Island, Hakodate.

4. *Strongylocentrotus pulcherrimus*.

Psammechinus pulcherrimus A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 357.

Strongylocentrotus pulcherrimus Mortensen, 1903. Ingolf Ech., pt. 1, p. 121. (No figure extant.)

Poriferous areas very broad with pore-pairs in arcs of 4, which are nearly horizontal at ambitus; spines small and very numerous.

18 specimens, of which 3 are bare, from Straits of Korea, 24 fms.; Japan; Japan, Misaki. Those from Misaki were labelled *Tripneustes angulosus*, and those from Straits of Korea *St. intermedius*.

As a rule in this species the primary spines are green and the tube-feet nearly white, but the spines may be white tipped. In one of the specimens from Misaki the spines are white, green only at base or not at all, and some are faintly banded with dull purplish on the distal half.

5. *Strongylocentrotus purpuratus*.

Echinus purpuratus Stimpson, 1857. Crust. Ech. Pac. Shores N. Amer., p. 86.

Strongylocentrotus purpuratus A. Agassiz, 1872. Rev. Ech., pt. 1, p. 165; 1873, pt. 3, pl. V a, figs. 5 and 6.

Pore-pairs 8; primary spines short; colour when adult purple; young more or less green.

12 specimens, of which 1 is bare and 3 are without locality labels. Localities represented are: British Columbia, Inverness; California; San Clemente Island; Gulf of California.

The label 'Gulf of California' is dubious; the species has not hitherto been recorded from the Gulf.

10. SPHAERECHINUS.

Desor, 1855. Syn. Ech. Foss., p. 134.

Type, *Echinus marii* Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 368.

Gill cuts deep; pore-pairs in arcs of 4 or 5; spines short; test usually high.

Although Desor says that the type of *Sphaerechinus* is 'Poursin comestible des côtes d'Europe', the only species whose name he gives is *Echinus marii*.

1. *Sphaerechinus granularis*.

Echinus granularis Lamarck, 1816. Anim. s. Vert., 3, p. 44.

Sphaerechinus granularis A. Agassiz, 1863. Bull. M.C.Z., 1, p. 23. 1873, Rev. Ech., pt. 3, pl. V a, fig. 7.

Form and colours very diverse, but the deep gill cuts and high test, with the short spines, are fairly distinctive.

103 specimens, of which 11 are without locality labels. Localities represented are: Europe; Island of Guernsey; Azores; near Azores, *Challenger* St. 75, 50-90 fms., sand; Madeira; Madeira, Funchal; Canary Islands, Las Palmas; Cape Verde Islands (*Challenger*); Spain and Portugal; Portugal; Mediterranean Sea; Balearic Islands, Port Mahon; France, Bay of Marseilles; Nice; Italy, Naples; Malta; Tunis, Bona Bay, 25-65 fms.; Tunis, Bay of Benzert (*Porcupine*). The single specimen from the Bay of Benzert was labelled *Echinus elegans*, while 2 from Las Palmas were labelled *St. lividus*. A fine specimen, 70 mm. in diameter, in the Exhibition Gallery was labelled '*Sphaerechinus australiae*. South and East Coasts of Australia'.

Few sea-urchins show greater diversity in the shape of the test, or in colour and general appearance, than does this well-known species. The usual range in the height of the test is from 50 to 70 per cent. of the diameter, but specimens beyond each of these limits are recorded. The present series range in size from 7 to 129 mm. in diameter, and in colour of spines from pure white to deep purple, dull pink or red and yellow. Young individuals often show the brightest colours; the specimen from Tunis labelled *E. elegans*, 7.5 x 5 mm., is very prettily variegated with red and yellow. Specimens with white spines have purple or dusky tests.

Some young specimens prove hard to recognize, not merely because of the colour, but because they are slow in acquiring polyporous plates in the ambulaera. The 5 *Challenger* specimens from the Cape Verde Islands, of which the largest is only 7×3.5 mm., have typical pedicellariae, but, although genital pores are present, there are but 3 pairs of pores to an are even in the uppermost ambulaeral plates: the test is blotched and the spines are banded.

Family 4. ECHINOMETRIDAE, Gray.

Ambitus more or less elliptical; no pits or sculpturing of coronal plates: ambulaeral plates compound, with 3–19 elements, but usually more than 4: oculars all exsert or becoming insert in sequence V, I, IV (not I, V, IV as usual).

This characteristically tropical family is well represented in the Museum, all of the 5 genera, including 13 valid species, being present. Few of the species are rare, and nearly all are well known. Specific limits are very hazy in *Echinometra*, and there is still a lack of evidence as to whether *Parasalenia* has one or two species.

1. PARASALENIA.

A. Agassiz, 1863. Bull. M.C.Z., 1, p. 22.

Type, *Parasalenia gratiosa* A. Agassiz, 1863. Bull. M.C.Z., 1, p. 22.

Pore-pairs in ares of 3; anal plates 4, subequal.

1. *Parasalenia gratiosa*.

A. Agassiz, 1863. Bull. M.C.Z., 1, p. 22. 1873, Rev. Ech., pt. 3, pl. III d, figs. 1 and 2.

Colours very dark, black when adult; milled rings white, in striking contrast; no red; genital 3 not excluded from periproct.

7 specimens, of which 1 has no locality label. Localities represented are: Chagos Archipelago, Diego, and Egmont (*Gardiner*); Maldiv Islands, Suvadiva (*Gardiner*); Queensland; New Hebrides. The specimens from Diego and the New Hebrides were labelled '*Echinometra lucunter*'.

The specimen without locality is much the largest *Parasalenia* yet recorded; it is 36 mm. long by 32 mm. wide, and the primary spines are 35–37 mm. long. The individual from Diego is very fine, 25 mm. long and 21 wide, with the primaries 30 mm. long; there are 5 anal plates and no spines whatever on the genital plates. The specimen from Egmont is only 14 mm. long; the test is very dark, and the primary spines are green, banded with a darker shade; there are 3–7 bands

on each spine, usually 4 or 5: the oral primaries are tipped with pinkish, but there is no red on test or spines.

The 2 young specimens from the New Hebrides are 6.5 and 10 mm. long: the width is a trifle less. The spines are green, the actinal ones banded distally (not at all sharply) with a lighter shade, and tipped with brownish. There is a distinct violet cast to the abactinal system, but there is no red anywhere. Genital 3 is not at all excluded from the periproct, and there are no spines on the abactinal system.

The young specimen from the Maldives is 10 mm. long and shows some red: the primary spines are banded green and white, but are red at very base and at tip: secondaries mostly red. Abactinal system with no spines or tubercles: genital plates all equally insert or nearly so.

In all of these examples the periproct is of moderate size and no genitals are excluded from it.

2. *Parasalenia poehlii*.

Pfeffer, 1887. Verhandl. Ver. Naturw. Unterh. Hamburg, 6, p. 110.
(No figure extant.)

Similar to *P. gratiose* but with more or less red in coloration, and genital 3 nearly or quite excluded from periproct.

7 specimens, of which 4 are bare and without locality. Localities represented are: Gulf of Suez; Maldive Islands, Suvadiva; Macclesfield Bank, 35-41 fms. The bare tests without locality were labelled *Echinometra viridis*; the Suvadiva specimen bore the label *Cidaris metularia*.

These specimens range from 5 to 19 mm. in length: the largest is 16 mm. wide and 8 high. The smallest specimen is red and white, much like *Eucidaris metularia*; the periproct is very small, and there are no spines or tubercles on any of the ocular or genital plates, but genital 3 is not excluded from the periproct. The Macclesfield Bank specimen is 8 mm. long, with a very pretty red and white coloration: there are no tubercles on the abactinal system: the periproct is very small, and genital 3 is nearly shut out by 2 and 4. The Gulf of Suez specimen is a little larger: the test is light green, and the primary spines are dirty white with 1-3 dusky bands and pink tips: each genital plate is perfectly smooth, pink at centre and whitish around the margins: genital 3 is very nearly excluded by 2 and 4. The 4 specimens without locality are typical *P. poehlii*, with the abactinal system quite red, in contrast to the light or dark brown colour of the test.

2. *ECHINOMETRA*.

Gray, 1825. Ann. Phil., 10, p. 426.

Type, *Echinus lucunter* Linné, 1758. Sys. Nat., ed. 10, p. 665.

Ambulacral plates of 4-8 elements: periproct with numerous plates: spines not peculiar.

1. *Echinometra insularis*.

H. L. Clark, 1912. Mem. M.C.Z., **34**, p. 374; pl. CXIV, figs. 3 and 4.

Pore-pairs in arcs of 5 or 6; primary spines deep purplish or reddish; ambulacra petaloid actinally.

1 specimen from Galapagos, Abingdon Island, labelled *Dia-dema mexicanum*!

This specimen is 77 mm. long by 72 wide and has primary spines 42 mm. long. The colour is deep purple. The ambulacra show a petaloid tendency orally, and the abactinal spines are not at all capitate or peculiar, but the pairs of pores are in arcs of 5 orally and 6 abactinally. In view of the size of the specimen, there can be little doubt that it is *E. insularis* rather than *E. vanbrunti*. Apparently no *Echinometra* has hitherto been reported from the Galapagos Islands.

2. *Echinometra lucunter*.

Echinus lucunter Linné, 1758. Sys. Nat., ed. 10, p. 665.

Echinometra lucunter Lovén, 1887. Bih. Svensk. Vet.-Akad. Handl., **13** (4), No. 5, p. 157. A. Agassiz, 1872. Rev. Ech., pt. 2, pl. X a, figs. 2-4 (as *E. subangularis*).

Pore-pairs in arcs of 7 or 8, or sometimes only 6; auricles stout with conspicuous supplementary 'tags'; colours diverse; spines rather stout.

161 specimens, of which 35 are bare and 80 are without locality labels. Localities represented are: Atlantic Ocean; West Indies; St. Croix; Jamaica; Anguilla and Barbuda; St. Vincent; Barbados; Trinidad; Venezuela, Puerto Cabello; Brazil; Pernambuco; Abrolhos Rocks; Rio Janeiro; Cape Verde Islands, St. Vincent; Santiago; Liberia, Cape Palmas; Gold Coast; Ascension; St. Helena; South Trinidad Island (*Terra Nova*). Most of these specimens were labelled *E. subangularis*, but several were named *E. viridis*, one *E. macrostoma*, and 2 *Strongylocentrotus dröbachiensis*.

The most interesting feature of this large series is the evidence it affords of the continuous distribution of the species across the tropical Atlantic from St. Croix and Puerto Cabello to Gold Coast and St. Helena. I find no reason to recognize *macrostoma* or any other variety. There appear to be no differences of importance between the specimens from the West Indies and those from St. Helena.

3. *Echinometra mathaei*.

Echinus mathaei de Blainville, 1825. Diet. Sci. Nat., **37**, p. 94.

Echinometra mathaei de Blainville, 1830. Diet. Sci. Nat., **60**, p. 206. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. IV b, fig. 4.

Pore-pairs in arcs of 4; colour and spines diverse, but rarely black, or with very stout spines.

160 specimens, of which 17 are without locality labels. Localities represented are: Egypt; Gulf of Suez; Red Sea;

Socotra ; Persian Gulf, Taub Island ; Muscat ; Abyssinia ; Aden ; Berbera ; Zanzibar ; German East Africa ; Isipingo ; Mozambique ; Madagascar ; Belo Bay ; Mauritius ; Rodriguez ; Amirantes, Darros Island ; Praslin (*Gardiner*) ; Coin Pedros (*Gardiner*) ; Maldives, Hululu Male (*Gardiner*) ; India, Tuticorin ; Ceylon ; Andaman Islands ; Cocos Keeling Islands ; Christmas Island (*Andrews*) ; South-eastern Borneo ; Philippine Islands, Zamboanga ; Japan, Hatzura ; Pescadores Islands ; Bonin Islands ; Australia, Port Essington ; King George's Sound ; Torres Strait, Dove Island ; Queensland ; Port Molle (*Alert*) ; Damma Island, 9-15 fms. ; Lord Howes Island ; New Guinea ; Solomon Islands ; Ugi ; Caroline Islands ; Pelew Islands ; New Hebrides, Undine Bay ; Loyalty Islands, Lifu ; Funafuti ; Rotuma ; Fiji ; Leruka ; Samoa ; Coast of Savaii. A specimen from Coin Pedros was labelled *Parasalenia gratiosa* ; 1 from German East Africa, *Stomopneustes variolaris* ; another, *E. oblonga* ; 3 from Savaii, *E. viridis* ; and many are naturally labelled *E. lucunter*. There are specimens with labels 'Chile', 'Port Natal', and 'Cape of Good Hope', but I do not trust these labels.

Probably the most abundant sea-urchin in the world, this species shows very great diversity in form of test and spines, as well as in colour. Various forms have been given names, one of the best marked of these being *E. picta*, but nothing is gained by the naming of inconstant forms, with no special geographical range. One specimen has the spines cream colour with a reddish tinge, and the bases red ; I have never seen another like it. The 3 specimens from Dove Island are very handsome with white-tipped green spines. From Fiji there are 2 young specimens with the milled rings on the primaries white as in *Parasalenia*. The specimen from Lord Howe Island is also much like *Parasalenia*.

4. *Echinometra oblonga*.

Echinus oblongus de Blainville, 1825. Dict. Sci. Nat., **37**, p. 95.

Echinometra oblongus de Blainville, 1830. Dict. Sci. Nat., **60**, p. 206. H. L. Clark, 1912. Mem. M.C.Z., **34**, pl. CXIV, figs. 1 and 2.

Pore-pairs in arcs of 4 or 5 ; colour usually black ; primary spines very stout on very large tubercles.

27 specimens, of which 19 are bare and without locality, 1 is from Mauritius and 7 are from Funafuti.

The Funafuti specimens are very good ; two of them are light dull purple rather than black. The identity of the bare tests is open to question, as there is no reliable distinctive feature in specimens which have lost spines, pedicellariae, and tube-feet ; but the large primary tubercles warrant leaving these specimens with the label they have evidently long borne. Probably this species is a form of *E. mathaei*.

5. *Echinometra vanbrunti*.

A. Agassiz, 1863. Bull. M.C.Z., 1, p. 21. H. L. Clark, 1910. Bull. M.C.Z., 52, pl. XI, fig. 1.

Pore-pairs in arcs of 7 or 8; auricles without big 'tags'; test low; spines long; colour deep purplish or dark reddish-brown.

8 specimens, of which 5 are bare, from Gulf of California; Mexico, Mazatlan; and Bay of Panama, Pearl Islands. The 2 from Pearl Islands are labelled *E. subangularis* and *E. rupicola*.

The largest of these is a bare test from Mazatlan, which measures 72 mm. long by 70 mm. wide and 40 mm. high.

6. *Echinometra viridis*.

A. Agassiz, 1863. Bull. M.C.Z., 1, p. 22. Lütken, 1864. Vid. Medd. f. 1863, pl. I, figs. 1 (5 of them) (as *E. michelini*). The figure in Agassiz (Rev. Ech., Pt. 1, pl. X a, fig. 1) is not *E. viridis*; it seems to be *E. mathaei*.

Primary spines slender, pointed, greenish tipped with purplish; other spines rather few; pore-pairs in arcs of 5.

2 specimens from the 'West Indies' and from Venezuela, Puerto Cabello. The one from 'West Indies' is said to have been labelled by Lütken as *E. michelini*.

This species, although well characterized, has caused much confusion, but when once its distinctive features are noted, it is very easily recognized. Of 8 specimens in the Museum labelled *E. viridis*, only two represent this species. *E. viridis* has hitherto been known only from southern Florida, the Greater Antilles and St. Thomas.

3. PODOPHORA.

Agassiz, 1840. Cat. Ectyp. Ech., p. 19.

Type, *Echinus atratus* Linné, 1758. Sys. Nat., ed. 10, p. 655.

Ambulacral plates of 9-12 elements; primary spines very short, thick and flat-topped, forming a smooth abactinal pavement; primary tubercles very large.

1. *Podophora atrata*.

Echinus atratus Linné, 1758. Sys. Nat., ed. 10, p. 655.

Podophora atrata Agassiz, 1840. Cat. Syst. Ectyp. Echinod., p. 19.

A. Agassiz, 1908. Mem. M.C.Z., 39, pls. XX-XXII.

Colour abactinally usually deep purple, rarely greenish; marginal primaries with rounded, sometimes swollen, ends; pore-pairs at ambitus in arcs of 9 or 10.

19 specimens, of which 4 are without locality labels. Localities represented are: Indo-Pacific Ocean; Zanzibar; Ceylon; Andaman Islands; Christmas Island; Sunda Straits.

One of the specimens without locality is 78 mm. long, 65 wide and only 30 high.

2. *Podophora pedifera*.

Echinus pedifer de Blainville, 1825. Dict. Sci. Nat., 37, p. 97.

Podophora pedifera Agassiz and Desor, 1846. Ann. Sci. Nat. (3), 6, p. 374. A. Agassiz, 1908. Mem. M.C.Z., 39, pls. VII-X.

Colour abactinally olive-green; marginal primary spines with flattened chisel-like tips: pore-pairs at ambitus in arcs of 10-12.

3 specimens, said to be from 'Chile, Coquimbo', and labelled '*Colobocentrotus atratus*'.

This species is reliably known only from some of the south-eastern Pacific Islands, notably Fakarava and Rangiroa in the Paumotus, but specimens labelled 'Chile' and 'Peru' have long been known in several museums. Although it is not impossible, it is highly improbable that the genus occurs on the South American coast. Shore collecting has failed to reveal it at either Juan Fernández or at Easter Island.

4. COLOBOCENTROTUS.

Brandt, 1835. Prodr. descr. Anim., p. 266.

Type, *Colobocentrotus mertensii* Brandt, 1835. Prodr. descr. Anim., p. 266.

Similar to *Podophora*, but primary spines and tubercles very much smaller, so that there are 10-12 on each coronal plate at ambitus, arranged in 2 horizontal rows.

1. *Colobocentrotus mertensii*.

Brandt, 1835. Prodr. descr. Anim., p. 266. A. Agassiz, 1908. Mem. M.C.Z., 39, pls. XXXIII-XXXIX (in part as *C. stimpsoni*).

Test low and flattened, its short diameter about nine-tenths of the long; colour grey-green.

7 specimens, of which 1 is bare and 2 are without locality labels. Localities given are: 'Pacific'; 'Australia'; 'Borneo'.

This is a very rare sea-urchin; this series shows that it is impossible to maintain *C. stimpsoni* as a species distinct from *C. mertensii*. The supposed distinction in form, *C. stimpsoni* having the short diameter of the test less than 0.90 of the long one and *C. mertensii* being more nearly circular in outline, breaks down completely. The 2 individuals labelled 'Australia' are 58 × 51 mm. (short diameter 0.88 of long) and 49 × 44 mm. (0.90). The 2 from the 'Pacific' are 55 × 48 mm. (0.87) and 50 × 45 mm. (0.90). One without locality is unusually narrow, 60 × 50 mm.

(0.83). As none of the specimens has the short diameter over 0.90 of the long, it might be claimed that all are *C. stimpsoni* and that *C. mertensii* is not represented, but this is highly improbable.

As regards the localities, 'Pacific' is no doubt correct; 'Australia' is highly improbable but not impossible; 'Borneo' is quite possible, but cannot be considered as beyond question, for the only known locality from which *Colobocentrotus* has yet come is the Bonin Islands.

5. HETEROCENTROTUS.

Brandt, 1835. Prodr. descr. Anim., p. 265.

Type, *Echinus mammillatus* Linné, 1758. Sys. Nat., ed. 10, p. 667.

Ambulacral plates of 10–19 elements; primary tubercles very large; primary spines long and very heavy.

1. *Heterocentrotus mammillatus*.

Echinus mammillatus Linné, 1758. Sys. Nat., ed. 10, p. 667.

Heterocentrotus mammillatus Brandt, 1835. Prodr. descr. Anim., p. 266. H. L. Clark, 1912. Mem. M.C.Z., 34, pls. CXV–CXVII.

Secondary spines of abactinal surface short, stout, flat-topped; pore-pairs in arcs of 10–12.

38 specimens, of which 5 are bare and 13 are without locality labels. Localities represented are: Indo-Pacific; Red Sea; Suez; German East Africa; Rodriguez; Mauritius; Philippine Islands, Luzon; Negros; Bonin Islands; New Guinea; Loyalty Islands, Lifu; Fiji.

2. *Heterocentrotus trigonarius*.

Echinus trigonarius Lamarek, 1816. Anim. s. Vert., 3, p. 51.

Heterocentrotus trigonarius Brandt, 1835. Prodr. descr. Anim., p. 266. H. L. Clark, 1912. Mem. M.C.Z., 34, pls. CXVIII–CXX.

Secondary spines abactinally short, tapering, pointed; pore-pairs in arcs of 14–19.

26 specimens, of which 9 have no locality labels. Localities represented are: Rodriguez; Mauritius; South Seas, Funafuti; Samoa.

Order 3. EXOCYCLOIDA, Jackson.

Periproct outside of genito-ocular ring in interambulacrum 5.
More or less marked bilateral symmetry.

Suborder 1. CLYPEASTRINA, Gregory.

Ambulacral areas petaloid abactinally. Ocular and genital plates fused into a compact mass. Peristome central. Lantern present, procumbent, highly modified. No peristomal gills.

Family 1. CLYPEASTRIDAE, Agassiz.

Auricles separate, each placed on the ambulacrum; test moderately high or flattened but rarely discoidal; anus marginal or inframarginal; genital pores 5.

This well-defined family is represented by 148 specimens of 13 species; one of these is new to science, and several are of interest from a zoogeographical point of view. There are 5 very young specimens which it is not possible to identify exactly: from Muscat, 2 specimens labelled *Laganum depressum*; from Socotra, 1 specimen labelled *Echinocyamus pusillus*; from Borneo, 2 specimens labelled *Echinanthus testudinarius*; these are all Clypeasters. There is also a semi-fossilized *Clypeaster* (no. 57-12-28-4) labelled *Clypeaster humilis*, which is not that species, and does not seem to be referable to any known recent species.

1. CLYPEASTER.

Lamarck, 1801. Sys. Anim. s. Vert., p. 349.

Type, *Echinus rosaceus* Linné, 1758. Sys. Nat., ed. 10, p. 665.

Poriferous areas of petals more or less incurved distally (if this is not well marked, the test is much flattened); anus inframarginal.

1. *Clypeaster audouini*.

Fourtan, 1904. Bull. Inst. Egypt. (4), 4, p. 418, pl. I, figs. 1-3.

Test very flat, with somewhat swollen margins, about as wide as long; petals usually narrow, nearly or quite closed; petaloid area usually 3-5 as long as test.

4 specimens, 2 from Muscat, labelled *C. humilis*, and 2 from Natal, Durban Bay.

The specimens from Muscat are rather small, 40×37 or 38 mm. Those from Natal are $55 \times 53 \times 9$ and $65 \times 62 \times 10$ mm.: the petals are notably wide and the petaloid area is only about half the test-length: but as the species is common on the Natal coast I do not think there is any doubt of their identity.

2. *Clypeaster australasiae*.

Echinanthus australasiae Gray, 1851. Proc. Zool. Soc. London, p. 34.

Clypeaster australasiae H. L. Clark, 1914. Mem. M.C.Z., 46, p. 32, pl. CXXXIV, figs. 1-3, pl. CXXXV, fig. 6.

Test rather high; lateral petals more or less widely open; tuberculation rather fine; ridges between pore-pairs rather broad with 6-12 primary tubercles, often in double series.

6 specimens, of which 1 is bare and 1 is without locality label. Localities represented are: Queensland, Brisbane Water; New South Wales, Port Jackson; *Challenger* St. 163, New South Wales, off Twofold Bay, 120 fms.; *Challenger* St. 161, Victoria, off Port Philip, 38 fms., sand. All but 2 of the specimens are labelled *Echinanthus testudinarius*.

The largest is from Port Jackson, and measures $122 \times 104 \times 37$ mm.

3. *Clypeaster humilis*.

Echinanthus humilis Leske, 1788. Add. ad Klein, p. 121.

Clypeaster humilis A. Agassiz, 1872. Rev. Ech., pt. 1, p. 100; H. L. Clark, 1914. Mem. M.C.Z., 46, pl. CXXXVII, pl. CXXXVIII, fig. 4.

Test low, flattened; margins thin; tuberculation fine; ridges between pore-pairs with a single regular series of 6-15 primary tubercles; poriferous areas converging rather abruptly and tending to close petals.

36 specimens, of which 7 are bare and 10 are without locality label. Localities represented are: Red Sea; Annesley Bay; Muscat; East of Persian Gulf, Mekran Coast (*Townsend*); cable between Muscat and Beluchistan; Madras; Tuticorin; Philippine Islands, St. 212, 10-20 fms., sand, and Amboina, 15-20 fms. (*Challenger*); Queensland, Port Denison (*Alert*).

The Red Sea, Annesley Bay and Muscat specimens are good, typical examples of this most variable and perplexing species. In the two specimens from the Mekran coast and the one from the Muscat cable the tuberculation is very sparse and the general appearance is not like *C. humilis*, but the differences are rather intangible. The 3 specimens from Madras are fine; the largest is $130 \times 120 \times 19$ mm.; the colour, light reddish-brown, is unusual. The single specimen from Tuticorin is a bare test with the interporiferous areas rather flat, the unpaired petal widely open and petals 2 and 4 not closed; one without locality, $133 \times 123 \times 18$ mm., is very similar; others intermediate between these and typical *C. humilis* are present. The *Challenger* specimens are young; probably they are *C. humilis*. The *Alert* specimen is large ($150 \times 135 \times 28$ mm.). It may be *C. telurus* H. L. Clark, which has been taken on the Queensland coast; or it may be considered as a connecting

link between *C. humilis* and *C. telurus*, indicating that the latter is no more than a variety.

A superb bare test without locality label is notable for its size, 163×148 mm., and for its flatness, as the height is only 24 mm.. So far as I can discover, this is the largest recorded example of this Clypeastroid, as the specimen Agassiz refers to in the 'Revision' (p. 510) is *C. subdepressus* and not *C. humilis*.

4. *Clypeaster japonicus*.

Döderlein, 1885. Arch. f. Naturg., 51 (1), p. 100. H. L. Clark, 1914. Mem. M.C.Z., 46, pl. CXXXVI, figs. 2-4, pl. CXXXVIII, fig. 5.

Lateral petals more or less completely closed; width of test more than 0.80 of length; tuberculation coarse, ridges between pore-pairs with only 4-6 primary tubercles; petals II and IV more than 0.80 of III.

13 specimens, of which 4 are bare and 1 has no locality label. Localities represented are: Japan; west coast of Japan, 40 fms.; Japan, Tsu-shima; Enoshima; Macclesfield Bank, 44 fms.; Ceylon. The specimens from Macclesfield Bank and Ceylon are labelled *Echinanthus testudinarius*.

The specimen from Ceylon is small ($56 \times 52 \times 15$ mm.), and it is less heavy and solid than examples of the same size from Japan, but it is nearer *C. japonicus* than to any other species. The individual from Macclesfield Bank is somewhat larger, and is more like Japanese specimens.

5. *Clypeaster miniaceus* sp. nov. PLATE IX, fig. 5.

Test 60 mm. long, 50 mm. wide and 12 mm. high, rather delicate, with moderately thick margins; almost flat between margin and tips of petals. Oral surface somewhat concave. Petals I and V, 16 mm. long by 9 mm. wide, with 29 pore-pairs, closed; petals II and IV, 13 by 9 mm., with 27 pore-pairs, completely closed; petal III, 16 by 9 mm., with 29 pore-pairs, open by 4 mm. Tuberculation of test rather sparse, only about 30 primary tubercles in an area 5×5 mm. on abactinal surface. In petal III, ridges between pore-pairs each have 2 or 3 primaries and 4-6 small miliaries. Periproct 3 mm. in diameter, not quite 3 mm. from margin.

Colour, orally nearly white; aborally reddish-white blotched and variegated with vermilion red.

Macclesfield Bank, 30-40 fms. One specimen.

This was listed by Bell as *C. scutiformis* (= *reticulatus*), but it is very different from that species, and is quite unique in its coloration. Other distinctive features are the low rather flat test, the relative size and form of the petals, and the coarse tuberculation. Apparently *C. leptotracon* is as nearly

related as any known species ; but the form of the petals distinguishes it at a glance.

6. *Clypeaster ochrus*.

H. L. Clark, 1914. Mem. M.C.Z., 46, p. 30, pl. CXLI, figs. 1-3.

Test much longer than wide, rather high, markedly concave orally ; tuberculation rather coarse with 4-6 primary tubercles on ridges between pore-pairs ; colour (dry specimens) light yellowish-brown or brown.

3 specimens, 2 bare and without locality, 1 from Lower California, La Paz. The La Paz specimen is labelled '*C. subdepressus*. Atlantic.'

The La Paz specimen was with a specimen of *C. speciosus* bearing the same 'Atlantic' label, although the two species occur only on the west coast of Mexico and in the Gulf of California. The present series confirms my faith in the validity of the species.

7. *Clypeaster ravenelii*.

Stonoclypus ravenelii A. Agassiz, 1869. Bull. M.C.Z., 1, p. 265.

Clypeaster ravenelii A. Agassiz, 1883. Mem. M.C.Z., 10, p. 43, pl. XV b, fig. 1, pl. XV c, fig. 1.

Test rounded pentagonal, as wide as long, rather high ; petals broad and widely open ; tuberculation of test coarse.

1 specimen from Gulf of Mexico, 'Blake' St. 36, 84 fms., labelled *C. subdepressus*.

This is a superb specimen, 133 mm. long, 133 mm. wide and 38 mm. high ; nearly as large as the largest hitherto recorded. The margin is 12 mm. thick. The colour is bright yellow-buff with a greenish cast.

8. *Clypeaster reticulatus*.

Echinus reticulatus Linné, 1758. Sys. Nat., ed. 10, p. 666 (*pars*).

Clypeaster reticulatus Desmoulins, 1837. Études sur les Éch. : Tab. Syn., p. 214. A. Agassiz, 1874. Rev. Ech., pt. 4, pl. XIII f, figs. 1, 2 (as *C. scutiformis*).

Test small (usually under 50 mm. long and never over 80), flattened but concave orally, and with very thick, more or less swollen margins ; petals II and IV scarcely $\frac{3}{4}$ of petal III, which is nearly closed ; tuberculation rather coarse with only 2-5 primary tubercles on ridges between pore-pairs.

40 specimens, of which 3 are bare and 8 are without locality labels. Localities represented are : Suez ; Red Sea ; British East Africa, Wasin, 10 fms. (*Crossland*) ; Natal, Durban Bay ; Mauritius ; Seychelles, 7-12 fms. ; Mascarenes, Providence Island, 69 fms., coral (*Alert*) ; Saya de Malha, 55 fms. (*Gardiner*) ; Macclesfield Bank, 13-40 fms. ; Holothuria Bank, 32 fms.

The specimens from Macclesfield and Holothuria Banks are small, mostly 7-16 mm. in length, with very prettily sculptured

tests; this sculpturing (as is well known) disappears as adult size is attained. The Mauritius and Red Sea specimens, as well as some of those without locality labels, are notably large, ranging from $66 \times 50 \times 15$ mm. to $75 \times 52 \times 14$ mm.; a wider specimen is 74×61 mm.; in all these the margin is 10–12 mm. thick.

One from Saya de Malha is deformed at the margin in ambulacrum V, as though a heavy stone had rested on it during a long period of growth.

Koehler (1922. Indian Mus. Ech.; Clyp., p. 66) has recently revived the genus *Rhaphidoclypus* for this species. After a re-examination of the internal pillars and walls in *C. reticulatus* and several typical Clypeasters, I am unable to admit the generic value of these structures. In a specimen of *C. australasiae*, 55 mm. long, the wall structure and position of the intestine is exactly as in *C. reticulatus*, and in larger specimens calcareous pillars and walls form between the intestine and the outer wall, but never to the extent shown in *C. subdepressus*. In *C. audouini* the intestine lies next to the outer wall as in *C. reticulatus*, but the outer wall is enormously thickened to 4 or 5 mm. The formation and position of calcareous pillars and walls in the Clypeastridae do not seem to be of much value for generic divisions.

9. Clypeaster rosaceus.

Echinus rosaceus Linné, 1758. Sys. Nat., ed. 10, p. 665.

Clypeaster rosaceus Lamarck, 1801. Anim. s. Vert., p. 349. A. Agassiz, 1872. Rev. Ech., pl. XI d, figs. 1, 2 (as *Echinanthus rosaceus*).

Test high, with the upper surface so arched one can scarcely speak of a 'margin'; oral surface deeply concave; interporiferous areas more or less elevated; colour, more or less dark reddish-brown.

19 specimens, of which 5 are bare and 6 are without locality labels. Localities represented are: West Indies; Bahamas; St. Thomas; Porto Rico, San Juan; St. Vincent; Barbados, Long Island.

The largest is one from St. Vincent, measuring $150 \times 127 \times 50$ mm. A specimen from Long Island is terribly deformed by a lateral compression which was evidently persistent for a very long period from early youth; the test measures 145 mm. long but only 68 mm. wide; it is 48 mm. high, but the oral depression-groove is 40 mm. deep; the anus is terminal.

10. Clypeaster rotundus.

Stenoclypus rotundus A. Agassiz, 1863. Bull. M.C.Z., 1, p. 25.

Clypeaster rotundus A. Agassiz, 1872. Rev. Ech., pt. 1, p. 100; H. L. Clark, 1914. Mem. M.C.Z., 46, pls. CXXXII and CXXXIII.

Test flat, its width about 0.90 (or more) of length ; tuberculation rather fine, with 6-15 primary tubercles on ridges between pore-pairs ; petal III about as widely open as I and V, not more.

2 specimens, of which 1 is without a locality label and 1 is from Panama, Pearl Islands.

These are fine examples of this notable species. The larger measures 152 by 144 mm., but is only 18 mm. high.

11. *Clypeaster speciosus*.

Verrill, 1870. Amer. Jour. Sci. (2), **49**, p. 95. H. L. Clark, 1914. Mem. M.C.Z., **46**, pl. CXXXV, figs. 1 and 2, pl. CXXXVI, fig. 5.

Test flattened but stout, with thick margins ; lower surface only slightly concave ; tuberculation coarse, the ridges between pore-pairs with 4-6 primary tubercles ; colour deep purplish-brown or blackish-purple.

7 specimens, of which 6 are bare and 6 are with no locality label ; 1 is from Lower California, La Paz.

The single bare specimen from La Paz carries a label showing that it is a cotype of *C. speciosus*.

12. *Clypeaster subdepressus*.

Echinanthus subdepressa Gray, 1825. Ann. Phil., **26**, p. 427.

Clypeaster subdepressus Agassiz, 1836. Mem. Soc. Sci. Nat. Neuchatel, **1**, p. 187. A. Agassiz, 1872. Rev. Ech., pt. 1, pl. XI b, figs. 1 and 2.

Test flat, width about 80 per cent. of length ; petals II and IV about 80 per cent. of petal III ; tuberculation rather fine ; oral surface flat ; petals more or less open.

8 specimens, of which 7 are bare and without locality labels, while 1 young one is from Brazil.

The largest of these is only 80 × 66 mm. ; the others are mostly 20-35 mm. long. As they are also bare and without locality labels, it is not beyond question that all are *C. subdepressus*. The largest has all the petals closed and seems to be *C. humilis* ; but it is much like some young specimens of *C. subdepressus*, and bears an old label reading *C. subdepressa*, which may be one of Grays ; it seems best to leave it with that identification. A specimen measuring 34 × 25 × 7 mm. has the petaloid area 20 mm. long, petal III, 10 mm., and petal II, 8 mm. ; the posterior margin of the test has a slight inconspicuous projection on the lower surface of which is the periproct ; this was labelled *C. humilis*, but it also bears an old label reading '*Echinanthus productus*'.

13. *Clypeaster virescens*.

Döderlein, 1885. Arch. f. Naturg., **51** (1), p. 102. H. L. Clark, 1914. Mem. M.C.Z., **46**, pl. CXXXIX, fig. 4, pl. CXL, figs. 1 and 2.

Test flat, nearly as wide as long ; petals short, widely open,

their width more than half their length ; tuberculation coarse, ridges between pore-pairs with only 1-4 primary tubercles.

2 specimens from off New Zealand (*Terra Nova*).

These are typical adult specimens of this well-marked species, but the report on the *Terra Nova* Echinoderms includes no reference to them: The larger is 114×110 mm.; both show the characteristic yellow-green colour. The occurrence of *C. virescens* in New Zealand waters is interesting.

Family 2. ARACHNOIDIDAE, Gregory.

Auricles separate ; test very flat, discoidal ; anus supra-marginal ; genital pores 4.

1. ARACHNOIDES.

Leske, 1778. Add. ad Klein, p. 154.

Type, *Arachnoides echinarachnius* Leske, l.c. = *Echinus placenta* Linné, 1758. Sys. Nat., ed. 10, p. 666.

Poriferous areas of petals straight, divergent ; margin of test very thin ; oral surface flat.

1. *Arachnoides placenta*.

Echinus placenta Linné, 1758. Sys. Nat., ed. 10, p. 666.

Arachnoides placenta Agassiz, 1841. Mon. Ech., Mon. Scut., p. 94.
Mortensen, 1921. Vid. Medd., 73, pl. VI, figs. 26 and 27.

Only 1 pair of interambulacral plates on oral surface of test at margin, in each interradius ; interambulacra at margin $\frac{1}{4}$ - $\frac{1}{3}$ as wide as ambulacra.

48 specimens, of which 4 are bare and 21 without locality labels. Localities represented are: Andaman Islands ; Philippine Islands ; Luzon, Tabaco ; New Britain ; Torres Strait, (*Jukes*) ; Australia ; Port Essington ; Cape York ; Cape Upstart ; Port Denison ; Cape Hillsborough (*Jukes*) ; Moreton Bay.

The largest in this series is 68 mm. long by 69 mm. wide, but most are much smaller. There is great diversity in the relative width of ambulacra and interambulacra ; as a rule the ambulacra are at margin only about one-fourth of interambulacra, but it is not very unusual to find them nearly a third ; in an example from Luzon, which is 38×37 mm., they are almost one-half. Even in this last-named individual there is only a single pair of interambulacral plates in the interradiar area at the margin of the oral side. This character seems to be reliable, and I am therefore convinced, against my earlier opinion, that Mortensen is right in maintaining that *A. zelandiae* is distinct from *A. placenta*.

2. *Arachnoides zelandiae*.

Echinarachnius zelandiae Gray, 1845. Deffenbach's Travels, 2, p. 265.

Arachnoides zelandiae Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 14. Mortensen, 1921. Vid. Medd., 73, pl. VI, figs. 24 and 25.

Each interradius with 2 or 3 pairs of interambulacral plates at edge of test on oral side; interambulacra at margin about one-half as wide as ambulacra.

20 specimens, of which 9 have no locality labels. The others are from: Australia, Cape Upstart (*Jukes*); Flinders Island; New Zealand; Massacre Bay.

The occurrence of this New Zealand form at Cape Upstart and Flinders Island is disconcerting; the specimens supposed to be from those localities are of moderate size, and undoubtedly of this species. The fact that *A. placenta* was taken at Cape Upstart makes me doubtful whether these *A. zelandiae* came from the same place.

The largest of the present series is 94 mm. by 96. The interambulacra are not always half as wide as the ambulacra; in some of these specimens they are hardly one-third.

Family 3. LAGANIDAE, A. Agassiz.

Auricles fused into a single piece on the interambulacra; test seldom discoidal, though flat, never with marginal slits or lunules; petals more or less perfect; madreporic pores numerous.

There are 342 specimens of 10 species; many are of more than ordinary interest, throwing much light on species limits and individual diversity. Two of the species of *Laganum* appear to be undescribed. Two very young specimens, labelled by Agassiz '*Peronella decagonalis*', are from off Tahiti (*Challenger*); these are too young for satisfactory identification.

1. *LAGANUM*.

Gray, 1825. Ann. Phil., 26, p. 427 (*Laguna* by error).

Type, *Echinodiscus laganum* Leske, 1778. Add. ad Klein, p. 140.

Genital pores 5 or 6, present in all the interambulacra.

1. *Laganum centrale* sp. nov. PLATE IX, figs. 1 and 2.

Test thin, flat at margins, somewhat elevated centrally, 46 mm. long, 38 mm. wide and 7 mm. high; margin less than 2 mm. thick. Genital pores 5. Petaloid area about 22 mm. long. Petals rather narrow, with only slightly convex

sides, well open at tip, widest near base. Peristome a trifle anterior, the mouth being only 22 mm. from the anterior margin of test. Periproct 3 mm. long by 3.75 mm. wide, situated just half-way between mouth and rear margin of test, so that the anus is 12 mm. from the margin.

Colour very pale, brownish-white.

Tongatabu Reefs (*Challenger*). 2 specimens.

These specimens were listed in the *Challenger* Report as *Peronellas*, but the presence of 5 genital pores indicates their position in *Laganum*. In the position of the periproct they resemble *L. laganum*, but in no other particular are they like that species. The general appearance is that of some of the *Peronellas*. The combination of 5 genital pores, narrow open petals and a centrally placed periproct is quite unique.

2. *Laganum decagonale*.

Scutella decagonalis de Blainville, 1827. Diet. Sci. Nat., 48, p. 229.

Laganum decagonale Bell, 1884. *Alert* Report, p. 122. Agassiz, 1841. Mon. Ech., Mon. Scut., pl. XXIII, figs. 16-20.

Test low; anus much nearer margin than mouth; petaloid area small; petals small but relatively broad with curved periferous areas converging to the nearly or quite closed tips.

35 specimens, of which 8 are bare and 2 are without locality labels. Localities represented are: 'Indo-Pacific area'; China; Macao; Java, Batavia Roadstead; Macclesfield Bank, 35-41 fms.; *Challenger* Stations 219, near Admiralty Islands, 150 fms., mud; 192, Arafura Sea, 129 fms., mud; 190, Arafura Sea, 49 fms., mud; and 188, west of Torres Strait, 28 fms., mud; Torres Strait (*Challenger*); *Holothuria* Bank (*Bassett-Smith*).

This series makes it evident that the East Indian region from China to Australia is the area inhabited by this species.

Individuals 25 mm. long frequently show no trace of genital pores, and one very fragile specimen from Torres Strait, 41 mm. long by 39 wide and 4.5 high, has no indication of them. Often they appear long before the animal is 25 mm. in length, but their frequent absence is a source of perplexity in identifying specimens; they do not always appear simultaneously; the specimen from *Challenger* St. 192 has only 3 pores.

The shape of the petals is quite constant and characteristic, but the degree to which they are open at the tip shows great diversity.

The specimen from Macclesfield Bank was labelled '*Arachnoides placenta*'; its peculiarities lead one to suspect that it may represent an undescribed species. The test is brown, rather heavy, 44 x 44 mm., and the tuberculation is much coarser, but closer than usual.

3. *Laganum depressum*.

Agassiz, 1841. Mon. Ech., Mon. Scut., p. 110, pl. XXIII, figs. 1-7.

Test with more or less pentagonal ambitus, its length usually decidedly greater than breadth; petaloid area rather large, its length 0.60 or more of test-length.

93 specimens, of which 12 are bare and 8 are without locality labels. Localities represented are: Indo-Pacific area; Gulf of Suez; Red Sea; British East Africa, Wasin, 10 fms. (*Crossland*); German East Africa, Dar-es-Salaam; Zanzibar, Mauritius; Amirantes, Poivre Islands, 13-20 fms. (*Alert*); Maldives, Mulaku (*Gardiner*); Gulf of Manaar, Rameswaram; Singapore; Macclesfield Bank, 31-46 fms.; Philippine Islands, Siquijor; west of Panay, St. 208, 18 fms., mud; and Amboyna, 15-25 fms. (*Challenger*); Torres Strait, Darnley Island (*Earl of Derby*, 1846); Australia; Queensland, Turtle Reef (*Rattlesnake*); New Caledonia; Kingsmill [= Gilbert] Islands; Funafuti (*Gardiner*); Tongatabu.

This notable series reveals the individual diversity of the species well, and throws much light on its distribution. Darnley Island and Tongatabu are the two most noteworthy localities.

As in *L. decagonale*, specimens of considerable size often lack genital pores; one 32×27 mm. has no trace of them. The thickness of the test shows great diversity in specimens from different localities, and there are some interesting differences in colour. The *Challenger* specimens from Amboyna, which is 22×19 mm., was named *L. putnami* by Agassiz, because the genital pores are not close to the madreporite: but they are only about 1 mm. distant and not well down in the interradii as in *L. putnami*; this individual has a sixth genital pore in interambulacrum 5, about a millimetre behind the normal one. The 26 specimens from Macclesfield Bank range from 9×8 to 38×34 mm.; they are mostly circular or rounded decagonal, few showing the typical pentagonal form. The seven from Singapore are of interest: the unusually long spines give the margin a conspicuous fringe and make the oral surface unusually soft, with its dense coat of relatively long, slender spines.

The specimens from Wasin are bright olive-yellow in colour and look very different from those from the Gilbert Islands. The largest is 35×29 mm., with the margins nearly 5 mm. thick. Similar stout specimens are found in the Gulf of Manaar: one of these is 46×40 mm. with a margin 5 mm. thick. The specimens brought by Gardiner from Funafuti are of two types; those labelled simply 'Funafuti' are relatively stout, handsome specimens, light yellow-brown; those labelled 'Funafuti lagoon' are almost as stout as those from Wasin, and are nearly black. The *Rattlesnake* specimens

from Queensland are very fine, 71 mm. long, 58 or 59 mm. wide, and 7 mm. thick at the margin, but the finest specimen of the whole collection is a superb one from Mauritius, 80 mm. long by 72 mm. wide.

4. *Laganum fudsiyama*.

Döderlein, 1885. Arch. f. Naturg., 51 (1), p. 104. H. L. Clark, 1914. Mem. M.C.Z., 46, pl. CXL, figs. 3 and 4, pl. CXLI, figs. 4-9.

Test high : petals narrow, poriferous areas little curved and tips widely open ; tuberculation relatively coarse.

1 specimen from *Challenger* St. 173, near Matuku, Fiji Islands, 310-315 fms., coral.

This specimen was identified as *L. decagonale* by Agassiz, but the form of test and of petals seems to prevent placing it in that species. It is $34 \times 31 \times 7$ mm., but as yet shows no genital pores : as a rule, genital pores appear in *L. fudsiyama* long before such a size is reached. Under the circumstances any identification of such a specimen is hazardous.

5. *Laganum laganum*.

Echinodiscus laganum Leske, 1778. Add. ad Klein, p. 140.

Lagana laganum de Blainville, 1830. Dict. Sci. Nat., 60, p. 196.

A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XIII c, figs. 6 and 7 (as *Laganum bonani*).

Test flat but thick ; periproct longer than wide, half-way between margin and mouth.

36 specimens, of which 31 are bare and 21 are without locality labels. Localities represented are : Indo-Pacific area ; Eastern Seas ; Philippine Islands, Siquijor ; Timor-Laut (*Forbes*) ; West Australia, Dirk Hartog Island.

The largest is $46 \times 44 \times 9$ mm. ; most are considerably smaller. Many show the conspicuous brown spots that characterize one of the colour forms of this species. The spotted and unspotted individuals do not seem to differ in any other way.

6. *Laganum mirabile* sp. nov. PLATE IX, figs. 9 and 10.

Test thin, flat, 42 mm. long, 40 mm. wide and 7 mm. high, with margins only 1.5 mm. thick. Genital pores 5. Petaloid area nearly 22 mm. long ; unpaired petal 10.5 mm. long by 4.75 mm. wide, almost as wide at tip as at middle, wide open, with poriferous areas widest near tip and pore-pairs nearly horizontal, not markedly oblique as usual ; petals II and IV 10×4 mm. at middle, 3 mm. across at tip, not closed, with poriferous areas widest at tip ; petals of I and V similar, but more widely open. All petals very blunt. Periproct nearly circular, not quite 2 mm. across, close to margin. Mouth

somewhat larger, rather abruptly sunken. No spines present except close to mouth. No pedicellariae noted.

Colour pale dull yellow, with poriferous areas dull purplish.

India, Madras (*Thurston*). 1 specimen.

The remarkable petals and the position of the periproct combine to make this one of the best marked species in the genus. It was labelled by Bell *L. decagonale*, but is very different from that species.

2. PERONELLA.

Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 13.

Type, *Laganum peronii* Agassiz, 1841. Mon. Scut., p. 123. Genital pores 4, wanting in interambulacrum 5.

1. *Peronella hinemoae*.

Mortensen, 1921. Vid. Medd., 73, p. 177, pl. VI, figs. 22 and 23.

Test nearly circular, thin and flat; oral surface concave; petals widest about the middle, narrowing gradually outward, widely open at tip; periproct about half-way between mouth and test margin.

4 specimens, 3 bare, from New Zealand, off North Cape, 70 fms. (*Terra Nova*).

This species is very near the Japanese *P. pellucida*, and more abundant material may show them to be identical. The petaloid area seems to be relatively a little smaller than in *P. pellucida*, and Mortensen has pointed out several other trifling differences; if these prove to be constant, the species will stand.

2. *Peronella lesueurii*.

Laganum lesueurii Agassiz, 1841. Mon. Ech., Mon. Scut., p. 116, pl. XXIV, figs. 3-6.

Peronella lesueurii A. Agassiz, 1872. Rev. Ech., pt. 1, p. 148.

Anus 0.15-0.30 of long radius from margin; petaloid area about half test-length or more; petals usually more or less nearly closed; test very flat and distinctly longer than wide; margins thin, about 0.07 of test-length; largest of the Laganidae, 100-150 mm. in length, and often more.

30 specimens, of which 8 are bare and 6 have no locality labels. Localities represented are: Japan, Misaki; China, Swatow; Hong Kong; Ceylon(?); Singapore; Australia; West Australia; west of Torres Strait, St. 188, 28 fms., mud (*Challenger*); Torres Strait, Thursday Island (*Alert*); Queensland, Port Denison, 4 fms. (*Alert*). Nearly all the above were labelled *Peronella decagonalis*, but one from Port Denison was named *Clypeaster humilis*, and one from Singapore *Laganum depressum*.

The genital pores are seldom present before the individual is 30–40 mm. long, and in this series there are specimens 51, and even 90 mm. long, in which no genital pores can be found. As a rule, the petaloid area is little if at all more than half test-length, but in the two specimens from Misaki it is a full 0.60, as in *P. orbicularis*. The stoutness of the test shows considerable diversity, but the margin is rarely thicker than 0.07 or 0.08 of test-length and may be much less; two extremes are found among the specimens from West Australia: one 120 mm. long has the margin 9 mm. thick, but another 143 mm. long has it only 4 mm. thick. The shape of the test shows considerable diversity; but none of the present specimens, excepting some under 40 mm. in length, have the width more than nine-tenths of the length; specimens over 80 mm. long have the width 0.70–0.83 of the length.

A specimen of 51×46 mm., labelled Australia, has the test very fragile, though it is 6 mm. thick at the margin; the colour is a pale greyish-purple; there are no genital pores. Four specimens exceed 140 mm. in length; the largest of these is 168×136 mm.; it has no locality label. The example from West Australia with margin 9 mm. thick is further remarkable in that the ambitus is an almost perfect ellipse, the test being wide, and equally so, at each end. The individual taken by the *Alert* near Thursday Island is very dark, an unusual condition in this generally light brownish species.

2 a. *P. lesueuri* var. *elegans*. PLATE VIII. figs. 1 and 2.

Polyaster elegans Michelin, 1859. Rev. Mag. Zool., no. 9, p. 4, pl. XIV, fig. 1.

Test 99 mm. long, 101 mm. wide and only 10 mm. high. Petaloid area 53 mm. in length, as wide as long. Periproct only 0.10 of long radius from margin.

‘Indo-Pacific’ and off C. Flinders, N.E. Australia, 10 fms. 3 bare tests.

This variety is unmistakable, as the width nearly equals or even exceeds the length of Michelin’s specimen, which was somewhat larger than the present one. I have never seen any specimens intermediate between the variety and the typical form except very young individuals, which are apt to be nearly circular.

3. *Peronella orbicularis*.

Echinodiscus orbicularis Leske, 1778. Add. ad Klein, p. 144.

Laganum orbiculare Agassiz, 1841. Mon. Ech., Mon. Scut., pl. XXII, figs. 16–20.

Peronella orbicularis A. Agassiz, 1872. Rev. Ech., pt. 1, p. 149.

Test rather stout, the margin about 0.12 of test-length in thickness; petaloid area rather large, 0.60 or more of test

length; periproct. 0.15–0.30 of long radius from margin; petals generally nearly closed.

101 specimens, of which 12 are bare tests and 12 are without locality labels. Localities represented are: Gulf of Martaban; Macclesfield Bank, 38 fms.; Philippine Islands, near Zamboanga, St. 212, 10–20 fms., sand, Amboyna, 15–25 fms., and Arafura Sea (*Challenger*); Australia; North-west Australia, Baudin Island, 8–15 fms.; Holothuria Bank, 15–34 fms.; $14^{\circ} 16' \text{ S.} \times 125^{\circ} 7' \text{ E.}$, 28 fms. (*Penguin*); 'Challenger' Stations 188, west of Torres Strait, 28 fms., mud, 187, Torres Strait, 6 fms., coral sand, and 186, Torres Strait, 8 fms., coral sand; Cape York (*Challenger*); Torres Strait, 10 fms., sand, and Prince of Wales Channel, 7–9 fms., sand (*Alert*); east coast of Australia; Albany Island, 3–4 fms. (*Alert*); Queensland, Cape Upstart (*Jukes*).

Although the differences between this species and *P. lesueuri* are not very weighty or well marked, they seem to be very constant, and adult specimens are usually distinguishable with ease. The genital pores appear early, and it is rare indeed to find them lacking in specimens over 25 mm. long. Of 17 specimens from Holothuria Bank, measuring from 10×9 mm. to 17×15 , only 3 show the genital pores, but 2 examples from the Arafura Sea, 9 and 16 mm. long respectively, show big genital pores; possibly females develop genital pores earlier than males. A specimen labelled 'Australia' has only 7 genital pores, 2 in interambulacrum 1, 1 in 2, 3 in 3, 1 in 4, and 0 in 5.

Of the specimens without locality labels, 3 small ones are a pretty red-orange; one from *Challenger* St. 187 is quite rosy red; 24 from the east coast of Australia are more or less brick-red. Probably the colour in life is red of some shade; possibly this is another point in which *P. orbicularis* differs from *P. lesueuri*.

The north coast of Australia and the Arafura Sea are the home of this species; all but half a dozen of the Museum specimens are from that region. Of the others, 2 are from Queensland, 2 from the Philippines, 1 from Macclesfield Bank, and 1 from the Gulf of Martaban. But the Burmese and Macclesfield Bank examples are too young for certain identification, and the Philippine specimens are bare and broken.

4. *Peronella peronii*.

Laganum peronii Agassiz, 1841. Mon. Ech., Mon. Scut., p. 123.

Laganum (Peronella) peronii Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 13.

Peronella peronii A. Agassiz, 1872. Rev. Ech., pt. 1, p. 149; pl. XIII e, figs. 4 and 5.

Test small but rather stout with broad petals; genital

pores placed in interambulacra at some distance from madreporite.

33 specimens, of which 9 are bare and 6 are without locality. Localities represented are: Queensland, Brisbane Water; New South Wales, Port Jackson; Bass Strait, Flinders Island; *Challenger* St. 162, 38-40 fms., sand; Tasmania; South Australia.

These range from 9.5×8.75 mm. to 44×40 mm. Genital pores appear in individuals about 15 mm. long. The single specimen from South Australia is very remarkable, being nearly perfectly tetramerous; it is a bare test, almost circular in form, 12 mm. in diameter; it has but 3 genital pores, interambulacrum 5 as usual being without one. The colour when dry, or in alcohol, is usually light brown, but 2 specimens without locality are deep brown.

Family 4. FIBULARIIDAE, Gray.

Auricles fused into a single piece on the interambulacrum; size small, generally less than 15 mm. in length; petals reduced and often rudimentary; madreporic pore usually single, rarely several pores are present.

Some 370 specimens of this little family give it an excellent representation in the Museum. Of the 9 species present, 2 seem to be undescribed, but unfortunately each is represented by but a single specimen. Most of the 20 or more species in the family are known only from bare tests, and specimens with spines on, in normal condition, are relatively rare, excepting only in the common European species of *Echinocyamus*.

1. FIBULARIA.

Lamarek, 1816. *Anim. s. Vert.*, 3, p. 16.

Type, *Fibularia trigona* Lamarek, l.c. = *Echinocyamus cranio-laris* Leske, 1778. Add. ad Klein, p. 150.

Test more or less elevated, without internal radiating walls, except posteriorly where they are usually indicated.

1. *Fibularia australis*.

Desmoulins, 1837. *Études sur les Éch.*, Tab. Syn., p. 240.

A. Agassiz, 1873. *Rev. Ech.*, pt. 3, pl. XIII, figs. 9 and 10.

Petals well formed, with small pores; periproct large, about equal to peristome; height of test about 0.40 of length; size large, up to 18 mm. in length.

3 specimens, all bare tests, one without locality, the others from Hawaiian Islands and from Loyalty Islands.

These are typical examples (at least the one from Hawaii is) of this species, which has recently been found to be common

at the Hawaiian Islands. I have lately examined a lot of over 200 specimens, taken off Honolulu, in 2-5 fms., by Mr. D. Thaanum. Mortensen (1921, Vid. Medd., **73**, p. 177) doubts whether the species that Agassiz and I term *F. australis* is the one so designated by Desmoulins and Gray. But there is no reasonable doubt of the matter. Mortensen lays great stress on Gray's (1855, Cat. Rec. Ech. Brit. Mus., p. 37) reference to a cross groove connecting the pore-pairs of the petals, and not finding this groove in specimens of the '*Fibularia australis* Benham' from the Kermadec Islands, he was doubtful about the Hawaiian form. After examining four specimens of Benham's *Fibularia*, received from Dr. Benham himself, I find that they are not even congeneric with the Hawaiian examples, and that Dr. Mortensen is right in referring them to *Echinocyamus*. The Hawaiian specimens, however, are typical *Fibularias*, without a trace of internal partitions; moreover, in large well-preserved specimens (i. e. not water-worn, for there were none with spines on among all the 200 examined!), the pores, at least in the basal part of the petals, are more or less connected by grooves—in some specimens distinctly, in others very slightly. This character is probably not important, and may depend mainly on age and condition, but it shows that these Hawaiian *Fibularias* are properly referred to *F. australis*.

The superficial resemblance between *F. australis* and *Echinocyamus polyporus* Mortensen is astonishing. Critical comparison reveals only 2 differences, aside from the obvious internal characters of the test; in *F. australis* the peristome is wider than long, often markedly so, whereas in *E. polyporus* it is just as long as wide; in *F. australis* the pore-pairs of the petals are quite oblique, especially distally, and in well-preserved large specimens the pores are (at least basally) connected by a furrow, whereas in *E. polyporus* the pore-pairs are relatively fewer, are more nearly horizontal, and have no connecting furrow.

2. *Fibularia craniolaris*.

Echinocyamus craniolaris Leske, 1778. Add. ad Klein, p. 150.

Fibularia craniolaris de Blainville, 1820. Dict. Sci. Nat., **16**, p. 512. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XIII e, figs. 1-3.

Test very high, more or less egg-shaped; anus usually not two-thirds as large as mouth; pores of petals usually smaller than genital pores.

50 specimens, of which 47 are bare and 33 are without locality labels. Eight are labelled 'Mediterranean Sea', no doubt an error. The localities to be trusted are: Gulf of Suez; Maldiv Islands, North Male (*Gardiner*).

Two specimens from the Maldives are about $8 \times 7 \times 6.5$ mm., and have the periproct much more than half the size of the mouth. They are thus quite like the figure in the 'Revision', referred to above.

3. *Fibularia volva*.

Agassiz and Desor, 1847. Ann. Sci. Nat. (3), **7**, p. 142. H. L. Clark, 1921. Carnegie Inst. Mar. Biol. Papers, **10**, pl. XXXV, figs. 6-9.

Pores of petals usually larger than genital pores: test about half as high as long: periproct not half as large as mouth: one or several madreporic pores.

29 specimens, of which 27 are bare tests. Localities represented are: Gulf of Manaar, Rameshwaram; coast of Korea, $34^{\circ} 8' N. \times 126^{\circ} 24' E.$; North Australia; St. 188, west of Torres Strait, 28 fms., mud (*Challenger*); Torres Strait, Prince of Wales Channel, 7 fms., sand (*Alert*).

One from Prince of Wales Channel is water-worn and stained, but the other is a very fine specimen, 7 mm. long, fully covered with short delicate spinelets: it was labelled '*Echinoneus cyclostomus*'.

Whether specimens with more than one madreporic pore are specifically identical with those having a single pore is doubtful. The larger specimens from the Gulf of Manaar have 3 or 4 madreporic pores and so have some of the North Australian specimens. But there seems to be no good reason for dividing this series into two groups on the basis of this single character.

2. *ECHINOCYAMUS*.

Leske, 1778. Add. ad Klein, p. 149.

Type, *Echinocyamus angulosus* Leske, *op. cit.*, p. 151 = *Echinus minutus* Pallas, 1774. Spic. Zool., **10**, p. 34.

Test more or less flattened, with rather stout walls, and internal radiating partitions bounding ambulacra (these walls may be well developed or only project a very trifling distance into the test-cavity.)

1. *Echinocyamus crenulatus* sp. nov. PLATE IX, figs. 3 and 4.

Test oval, flat, 7 mm. long, 6 mm. wide and less than 1.5 mm. high. Posterior margin very slightly crenulate with 8 lobes; the test is bare and somewhat water-worn, so that the tips of several of these lobes are worn off and thus there are minute openings into the test cavity. Inner supporting walls of test well developed. Apical system a trifle posterior to centre. Genital pores 4, no larger than largest ambulacral pores and much smaller than primary tubercles. Madreporic pore single, large. Ocular pores hardly discernible. Petals short and wide; petal III with 10 pore-pairs to a side;

petals II and IV with 8; petals I and V with 7. Posterior petals distinctly smaller than anterior pair, but unpaired petal is largest of all. All are well formed with diverging poriferous areas. Oral surface flat. Peristome central, rounded pentagonal, about as wide as long, 1 mm. in diameter. Periproct longer than wide, about 0.60 by 0.50 mm., nearer to mouth than to margin.

Gambia, June 27, 1903. One specimen.

This interesting little Echinoid was found among a lot of young *Rotula orbiculus*, and was at first considered to be a very small individual of that species, as the crenulate character of the posterior end of the test is essentially the same as in young *Rotula*, although less marked. But the genital pores are well developed, whereas in *Rotula* they do not appear until the test is 10 mm. or more in length; there is a single, large madreporic pore, and internal radiating partitions are present, so that it must be considered to be an *Echinocyamus*. From the other species of this genus it is readily distinguished by the shape, the position of apical system and of periproct, the form of the petals, and the flat oral surface.

2. *Echinocyamus elongatus*.

H. L. Clark, 1914. Mem. M.C.Z., 46, p. 61, pl. CXXVI, figs. 9-11.

Test long and narrow, its width about 0.70 of length, markedly concave orally, at least posterior to mouth; poriferous areas usually with fewer than 10 pore-pairs in each.

1 specimen from Macclesfield Bank, 35-40 fms.

This individual is 8 mm. long by 5.75 mm. wide. It is slightly damaged abactinally, but I can find no reason for not assigning it to this species, which was previously known from Hawaii and Guam.

3. *Echinocyamus grandiporus*.

Mortensen, 1907. *Ingolf* Ech., pt. 2, p. 33, pl. XII, figs. 1-5.

Petals more or less imperfect or ill formed; ocular pores nearly or quite as large as genital pores.

8 specimens, of which 2 are bare and are labelled only 'Gulf Stream Expl. Wyville Thomson coll.', and 6 are from *Challenger* St. 122, off St. Thomas, 32-400 fms., labelled *E. pusillus*.

The *Challenger* specimens are good examples, 5-7 mm. long, but those from the Wyville Thomson collection are bare and very young; they have a label in Agassiz's handwriting: '*Stonoclypus prostratus* juv.'

4. *Echinocyamus grandis* sp. nov. PLATE IX, figs. 6-8.

Test oval, rather high, 14 mm. long by 11 mm. wide, and 5 mm. high, evenly arched abactinally. Apical system very

slightly anterior to centre. Inner supporting walls of test well developed. Genital pores 4, larger than ambulacral pores, and somewhat larger than primary tubercles. Madreporic pore single, smaller than genital pores. Ocular pores much smaller than genitals. Petals well developed; petals I, III and V about 4 mm. long, petals II and IV a trifle shorter; there are 11-14 pore-pairs on each side; poriferous areas nearly parallel, diverging at tip only a trifle. Oral surface concave, the mouth very deeply and rather abruptly sunken. Peristome circular, about 2.5 mm. in diameter. Periproct about 1.5 mm. in diameter, nearer mouth than margin. Test bare and white, without spines or pedicellariae.

Seychelle Islands, 34 fms. (Gardiner). One specimen.

This is probably the specimen that Bell (1909, Trans. Linn. Soc.; Zool. (2), **13**, p. 20) lists as *Fibularia volva*, but there is no doubt it is an *Echinocyamus* and a very distinct species. The rather high test, well-marked petals, large genital pores, and deeply concave oral surface distinguish it from the other species of the genus.

5. *Echinocyamus minutus*.

Echinus minutus Pallas, 1774. Spic. Zool., **10**, p. 34.

Echinocyamus minutus de Blainville, 1834. Man. Act. Zool., p. 214.

Mortensen, 1907. *Ingolf* Ech., pt. 2, pl. XII, figs. 27, 29, and 31 (as *Echinocyamus pusillus*).

Test flat, wide, very slightly concave orally; petals with about 6-9 pore-pairs in each of the slightly diverging poriferous zones; ocular pores much smaller than genitals; periproct about half as large as peristome.

281 specimens, of which 181 are bare tests and 69 are without locality labels. Localities represented are: Finmark; Norway; Lofoten Islands; Hardanger Fjord; Sweden, Bohuslan; Shetland, Sandwich Bay; Scotland, Lewis Island; Moray Firth, 130 fms.; Mouth of Sound of Mull, 68 fms.; the Minch; Stations 38, 74 fms., and 90, 453 fms. (*Porcupine*); England, off Liverpool; Plymouth; Ireland, off Wexford, 30-40 fms.; Birterbury Bay; Mediterranean; Barbary Coast; Corsica; Marseilles, 6 fms.; 'Gulf Stream Exploration, Wyv. Thomson coll.'

The largest specimen is from the Hardanger Fjord and measures 16 × 15 mm.; it has 9-11 pore-pairs in the poriferous areas. The smallest are about 2.5 mm. long; they show no genital pores and have only 2 or 3 pore-pairs in each poriferous area; examples not quite 3 mm. long may show 4 well-developed genital pores. The specimens from *Porcupine* St. 90 are small and show no genital pores; there is some doubt as to their identity.

Mortensen (1920, Vid. Medd., **72**, p. 68) takes me to task for

using Pallas's name for this species. He emphasizes the statement that Pallas 'does not name any *Echinus minutus* at all'. He then quotes the crucial sentence from Pallas and adds his own translation: 'I have added some small sea-urchins.' I think that Pallas certainly named the small sea-urchins that he figured, *Echinus minutus*; this is clearly shown by the type in which the words are printed. That he used the accusative plural instead of the nominative singular is not important, for all through the fascicle he varied case and number of his scientific names to suit the sense. The omission of the name from the index is natural, as the index includes only the names used for headings of sections, paragraphs, &c., printed in big type, and *Echinus minutus* was not so used. Finally, if *Echinus minutus* is not the name of the objects shown in figs. 24 and 25 of Pallas's plate I, then there is no name given at all, and this not only does violence to the context, but is unique in the fascicle.

Mortensen goes on to say that even if Pallas did create the name *Echinus minutus*, it should be used for the *Fibularia* that Pallas also figures under his 'Echinos minutos'. But again Dr. Mortensen's reasoning seems to me faulty. Pallas included at least two species in his *Echinus minutus*, but Gmelin (1788, Sys. Nat., Linn., ed. 13, p. 3194) very clearly restricted the name to the form common on the coast of Belgium.

6. *Echinocyamus scaber*.

De Meijere, 1903. Tijdschr. Nederl. Dierk. Ver. (2), 8, p. 5. 1904, *Siboga* Ech., pl. VI, figs. 46 and 47; pl. XVII, figs. 301-5.

Test flat with imperfect petals, containing few pore-pairs; glossy tubercles of test high and numerous, making surface of test very rough.

One specimen from New South Wales, Port Jackson (*Challenger*); labelled *Fibularia australis*.

This specimen, which is $5.5 \times 5 \times 2$ mm., is undoubtedly an *Echinocyamus*, but it is not certain that it is *E. scaber*. The periproct is much nearer to the test margin than it is to the mouth, and there are 4 or 5 pore-pairs in each poriferous area—more than would be expected in *E. scaber* of this size. However, the very scabrous appearance of the test justifies referring the specimen to this species until more Port Jackson material is available.

Family 5. SCUTELLIDAE; Agassiz.

Test flat, usually discoidal, often with lunules or with marginal slits; auricles fused into a single piece situated on the interambulacrum; ambulacral furrows of the oral side distinct, at least the posterior reaching the margin.

There are more than 450 specimens of this family in the collection, representing 18 species, but all are well-known forms, and the material calls for little discussion.

1. ECHINARACHNIUS.

Gray, 1825. Ann. Phil., 26, p. 428.

Type, *Scutella parma* Lamarek, 1816. Anim. s. Vert., 3, p. 11.

Test without marginal slits or lunules : abactinal system at apex of test ; petals about equal ; periproct marginal.

1. *Echinarachnius mirabilis*.

Scaphechinus mirabilis A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 359.

Echinarachnius mirabilis A. Agassiz, 1872. Rev. Ech., pt. 1, p. 107, pl. XIII a, figs. 5 and 6.

Test flat, often wider than long, with actinal ambulacral furrows forking proximal to middle.

21 specimens, of which 1 is bare. All are from Japan ; Yokohama ; Enoshima ; Inland Sea. Those from the Inland Sea were labelled *Arachnoides placenta*.

Young individuals of this interesting sand-dollar are remarkable for their very delicate, usually white or very light-coloured tests, while adults are fairly stout and are deep violet in colour. But small individuals are not always young, and one of those from Enoshima is notable because, although it is only 19 mm. long and 22 mm. wide, it has much the texture and colour of adults. The 3 specimens from the Inland Sea are also small and dark coloured. The difference noted in colour and texture is probably most closely associated with age, but may possibly be correlated with locality or habitat. The largest of the present series is from Yokohama, and measures 71 mm. long by 76 mm. wide.

2. *Echinarachnius parma*.

Scutella parma Lamarek, 1816. Anim. s. Vert., 3, p. 11.

Echinarachnius parma Gray, 1825. Ann. Phil., 26, p. 428.

A. Agassiz, 1872. Rev. Ech., pt. 1, pl. XI c, figs. 4 and 5.

Test variable in height and solidity, but vertical diameter is generally less than 0.20 of longitudinal ; actinal ambulacral furrows forking only near distal end.

96 specimens, of which 23 are without locality labels. Localities represented are: North America ; Labrador ; Newfoundland ; Gaspé Bay ; Grand Manan ; Cape Cod Bay ; Vineyard Sound ; Pacific coast, Puget Sound. There are also specimens labelled 'Equador', 'India', and 'South Australia'.

The Puget Sound specimen is a very fine one, 75×76 mm. The individual from 'India' is peculiar in that petal IV is constricted at the middle. Careful comparison of the specimens labelled 'South Australia' with examples of *E. parma* of the same size from the New England coast shows that these supposedly Australian sand-dollars are certainly *E. parma*, about half grown. As they have been in the Museum since 1841 I have no doubt the 'South Australia' has become associated with them by mistake.

2. DENDRASTER.

Agassiz and Desor, 1847. Ann. Sci. Nat. (3), 7, p. 135.

Type, *Scutella excentrica* Eschscholtz, 1831. Zool. Atlas, 4, p. 19.

Test rather stout, wider than long, with abactinal system posterior to apex; no slits or lunules; posterior petals much shorter than others; periproct on oral surface.

1. *Dendroaster excentricus*.

Scutella excentrica Eschscholtz, 1831. Zool. Atlas, 4, p. 19.

Dendroaster excentricus Agassiz and Desor, 1847. Ann. Sci. Nat. (3), 7, p. 135. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XIII a, figs. 1-4.

Apical system large, with posterior pair of genital pores twice as far apart as anterior. Colour greyish-green, dark grey, or nearly black.

23 specimens, of which 10 are bare and 1 is without locality label. Localities represented are: Queen Charlotte Islands; Vancouver; California; San Francisco; Anaheim Bay.

3. ECHINODISCUS.

Leske, 1778. Add. ad Klein, p. 131.

Type, *Echinodiscus bisperforatus* Leske, 1778. Add. ad Klein, p. 132.

Test very flat; only 2 lunules or marginal slits present, and these placed one in each posterior ambulacrum.

1. *Echinodiscus auritus*.

Leske, 1778. Add. ad Klein, p. 138. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XIII c, figs. 1 and 2.

Posterior ambulacra each with a deep narrow marginal slit; test often longer than wide.

23 specimens, of which 6 are bare and 8 are without locality labels. Localities represented are: Suez; Red Sea, Ras Mohammed; Persian Gulf; Mekran Coast (*Townsend*); Karachi; British East Africa, Mombasa; Zanzibar (*Crossland*); Portuguese East Africa, Lumbo; Mauritius; India; Madras.

The specimens from Lumbo are fine, with thin tests and long narrow marginal slits; one of the specimens from Mauritius is the largest, 183×178 mm. A bare test without locality, 170 mm. long by 177 mm. wide, is deformed by an injury, as though the rear end on the left-hand side had at some time been bitten off; the marginal slit on the right-hand side is 33 mm. long by 10 mm. in breadth.

2. *Echinodiscus bisperforatus*.

Leske, 1778. Add. ad Klein, p. 132. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XIII b, figs. 5 and 6 (as *Echinodiscus biforis*).

Test wider than long, with a lunule in each posterior ambulacrum; lunules usually as long as or longer than longest petal; petals II and IV longer than I and V.

36 specimens, of which 16 are bare and 6 have no locality labels. Localities represented are: Gulf of Suez; Suez; Red Sea; Abyssinia; Natal, Port Natal; Cape Colony, Mossel Bay, 4–12 fms.; Madras; Labuan; New Caledonia; West Australia (*Bowerbank*).

This species shows such great diversity in form and in proportions of test, petals and lunules, that comment might be made on almost every specimen. A very large one, without locality, measures 86×96 mm. One from West Australia is nearly as large; it approaches closely to *E. tenuissimus*; petal I is 17 mm. long and petal II is 18, and the lunule is 18×3 mm. The specimen from Labuan has petal I, 11.5 mm. and petal II, 13 mm., but the lunule is only 10×2 . Two small ones from Port Natal are at the other extreme, for the lunule is 16×2 mm., and the petals are 6 and 8 mm. respectively. A bare test from Port Natal is abnormal; the right lunule is 11×4 mm., but the left one only 6×2.5 mm. The 12 specimens from Mossel Bay are water-worn to varying degrees, and range in size from 40×46 to 72×86 mm.; the best are uniformly deep purple. Two specimens from the Gulf of Suez are not only the largest but are the highest relatively, being quite pyramidal. They measure about $97 \times 105 \times 15$ mm.

2 a. *E. bisperforatus* var. *truncata*.

Lobophora truncata Agassiz, 1841. Mon. Ech., Mon. Scut., p. 66, pl. XI, figs. 11–16.

Echinodiscus bisperforatus var. *truncatus* H. L. Clark, 1914. Mem. M.C.Z., 46, p. 72.

Lunules about as short as shortest petals.

9 specimens, of which 7 are from Penang and 2 from New Caledonia.

Two New Caledonia specimens are very fine, 111×114 mm. The 7 Penang specimens range from 32×37 to 68×73 mm.;

the longest petals are 6.25–17 mm. and the shortest are 5–13 mm. ; the lunules are 6–15 mm., as a rule a trifle longer than the shortest petals.

3. *Echinodiscus tenuissimus*.

Lobophora tenuissima Agassiz and Desor, 1847. Ann. Sci. Nat. (3), 7, p. 136.

Echinodiscus tenuissimus Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 20. Michelin, 1861. Rev. Mag. Zool., pl. IX, fig. 1 (as *Lobophora deplanchei*).

Test very flat with thin margins, longer than wide, with a short lunule in each posterior ambulacrum ; petals II and IV little if any longer than I and V.

2 specimens from New Caledonia and from New Hebrides Islands, Tanna, Port Resolution.

These are fine, but not quite typical of this handsome species ; in view of the great diversity shown by *E. bisperforatus*, more material is necessary before this form can be regarded as unquestionably valid. The Tanna specimen is 84 × 82 mm., with the lunules 15 × 5, petals I and V, 14 mm., and petals II and IV, 15 mm. The New Caledonian specimen is more like *E. bisperforatus* in form ; it is 120 mm. wide and 115 mm. long, but the lunules are only 15 × 4 mm. ; the paired petals are 19 mm. long and the unpaired is 21.5 mm.

4. *ASTRICLYPEUS*.

Verrill, 1867. Trans. Conn. Acad., 1, p. 311.

Type, *Astriclypeus manni* Verrill, 1867. Trans. Conn. Acad., 1, p. 311.

Test rather stout, nearly circular, with 5 lunules, 1 in each ambulacrum.

1. *Astriclypeus manni*.

Verrill, 1867. Trans. Conn. Acad., 1, p. 311. A. Agassiz, 1873 Rev. Ech., pt. 3, pl. XIII d, figs. 2–4.

Size moderate, 75–100 mm. or more in diameter ; colour, fawn or brown.

2 specimens, both from Japan ; 1, a bare test, is further labelled Inland Sea, Singisima.

This very easily recognized and handsome species has been known from Japan for nearly sixty years, but has not yet been taken elsewhere.

5. *ENCOPE*.

Agassiz, 1841. Mon. Ech., Mon. Scut., p. 45.

Type, *Echinodiscus emarginatus* Leske, 1778. Add. ad Klein, p. 136.

Test stout, with a posterior interambulacral lunule, and with marginal notches or slits or lunules in 2 or more of the ambulacra ; genital pores 5.

1. *Encope californica*.

Verrill, 1871. Trans. Conn. Acad., 1, p. 586. (No figure of this species has ever been published.)

Test only moderately heavy, highest posterior to abactinal system, at anterior end of interambulacral lunule ; ambulacra with completely closed, rounded lunules ; none of the petals much exceed 0.25 test-length.

7 specimens, of which 2 are bare and 1 is without locality label. The others are from the Gulf of California, 2 of them from La Paz ; 2 labelled 'San Francisco', which may have been bought in that city, or may perhaps come from San Francisquito, on the east coast of Lower California.

2. *Encope emarginata*.

Echinodiscus emarginata Leske, 1778. Add. ad Klein, p. 136.

Encope emarginata Agassiz, 1841. Mon. Ech., Mon. Scut., p. 47, pls. VII and VIII (as *E. valenciennesii*) and pl. X.

Test moderately stout, elevated equally both anterior and posterior to abactinal system ; interambulacral lunule large, very variable in size and form, length 0.16–0.35 test-length.

58 specimens, of which 39 are without locality labels. Localities represented are : West Indies ; Nicaragua ; Colombia, Cartagena ; Brazil ; Rio Janeiro. There is also a good specimen labelled 'South Carolina'.

Some of the specimens without locality are of interest. One lot of 12 young ones (30×30 – 46×46 mm.) is unusually light coloured ; none show genital pores. On the other hand, a specimen 105 mm. long has no fewer than 8 genital pores, 1 in interambulacrum 1, 2 in 2, 1 in 3, 2 in 4 and 2 in 5.

3. *Encope grandis*.

Agassiz, 1841. Mon. Ech., Mon. Scut., p. 57, pl. VI.

Test very heavy, about as wide as long ; margins 5 mm. thick ; interambulacral lunule big, oval ; marginal notches wide and moderately deep.

4 specimens, of which 3 are bare and 2 are without locality.

This is undoubtedly the most solid sea-urchin known. An adult probably contains more carbonate of lime in proportion to the total weight than any other Echinoderm. It is known only from the Gulf of California.

4. *Encope michelini*.

Agassiz, 1841. Mon. Ech., Mon. Scut., p. 58, pl. VI a, figs. 9 and 10.

Test highest posterior to abactinal system at anterior end of interambulacral lunule ; ambulacral marginal slits rarely, if ever, closed to form lunules, often shallow, and even wanting

in the anterior ambulacra; petaloid area large, posterior petals about one-third of test-length.

1 specimen labelled '*E. emarginata*, California'.

This is a typical *E. michelini*, a species known only from the Gulf of Mexico.

5. *Encope micropora*.

Agassiz, 1841. Mon. Ech., Mon. Scut., p. 50, pl. X a, figs. 4-8.

Test distinctly highest anteriorly; interambulacral lunule small, 0.10-0.17 of test-length; anterior end of interambulacral lunule nearer to distal end of posterior petals than to centre of abactinal system.

22 specimens, of which 14 are bare and 9 are without locality labels. Localities represented are: West Coast of Central America; Costa Rica, Punta Arenas; Bay of Panama, Pearl Islands; Ecuador, Guayaquil. There is also a specimen labelled 'West Indies'.

The largest of these is $157 \times 151 \times 18$ mm., but the majority are young individuals, 41×44 - 50×51 mm., labelled *Mellita stokesii*. Examination of these confirms my belief that '*M. stokesii*' is the young of *E. micropora*.

6. *Encope perspectiva*.

Agassiz, 1841. Mon. Ech., Mon. Scut., p. 51, pl. X b, figs. 1-5.

Test distinctly highest anteriorly; interambulacral lunule small, its anterior end nearer to centre of abactinal system than it is to distal end of posterior petals.

4 specimens, of which 2 are bare. One is without locality; the others are from Mazatlan, near the entrance to the Gulf of California, and from the Mexican coast, 20 miles north of Mazatlan.

The specimens from Mazatlan are 65×65 mm. and 70×70 mm.; they are flat and thin like *Mellita*, but they seem to be the young of *E. perspectiva*.

6. MELLITA.

Agassiz, 1841. Mon. Ech., Mon. Scut., p. 34.

Type, *Scutella quinquefora* Lamarck, 1816. Anim. s. Vert., 3, p. 9 = *Echinodiscus quinquiesperforatus* Leske, 1778. Add. ad Klein, p. 133.

Test flat and thin, with an interambulacral lunule and 4 or 5 ambulacral lunules; genital pores 4.

1. *Mellita longifissa*.

Michelin, 1858. Rev. Mag. Zool., 10, p. 360, pl. VIII, fig. 1.

Lunules 5; interambulacral lunule long and very narrow, 0.25-0.40 test-length; its width is less than 0.10 of its length.

5 specimens, of which 1 is bare, from Gulf of California and Mexico, Mazatlan.

2. *Mellita quinquesperforata*.

Echinodiscus quinquesperforatus Leske, 1778. Add. ad Klein, p. 133.

Mellita quinquesperforata Meissner, 1904. Bronn's Thierreich, 2, p. 1384. A. Agassiz, 1872. Rev. Ech., pt. 1, pl. XII c, figs. 1 and 2 (as *M. testudinata*).

Lunules 5: interambulacral lunule usually less than 0.20 test-length: if more, its width is 0.15–0.20 of its length.

34 specimens, of which 10 are bare and 16 are without locality labels. Localities represented are: Off Cape Hatteras, 16 fms.; South Carolina; Florida; Jamaica; Porto Rico. There is also a specimen labelled 'Casa Blanca?'

3. *Mellita sexiesperforata*.

Echinodiscus sexiesperforatus Leske, 1778. Add. ad Klein, p. 135.

Mellita sexiesperforata Meissner, 1904. Bronn's Thierreich, 2, p. 1384. Agassiz, 1841. Mon. Ech., Mon. Scut., pl. IV, figs. 4–7, pl. IV a, figs. 11–12 (as *M. hexapora*).

Lunules 6: interambulacral lunule long and narrow, its length at least twice, and generally several times, its breadth.

52 specimens, of which 11 are bare and 19 have no locality label. There are 5 specimens from the 'West Indies', 24 from St. Vincent, and 1 from St. Thomas; 3 are labelled 'Red Sea. *Mellita erythraea*'.

Mellita is an American genus, and its occurrence in the Red Sea is highly improbable: the specimens here called *M. erythraea*, and supposedly from the Red Sea, are undoubtedly *M. sexiesperforata*; one is 94×91 mm. but the others are small.

A specimen without a locality label is $35 \times 32 \times 3.75$ mm. and was labelled *Echinodiscus biforis*. It is curiously malformed and asymmetrical; the longitudinal axis passes through the apical disk, periproct, and peristome as it should, but the right-hand margin of the test is 18 mm. from that axis, while the left-hand side is only 14 mm. All the lunules, except that in ambulacrum II, are normal, though somewhat short and wide; but the lunule in II is present only on the oral side and is very small. There are no genital pores in interambulacra II and V, but the others are present and normal. All the petals are small and pointed. Possibly this curious specimen may not be a *M. sexiesperforata* (it might be *M. pacifica*).

Among the other specimens without locality are a pair of very fine ones, evidently selected examples: the larger is 93×90 mm., and the smaller is 85×98 ; these exhibit well the two possible extremes in form: the smaller has no genital pore in interambulacrum I.

7. ROTULA.

Agassiz, 1841. Mon. Ech., Mon. Scut., p. 23.

Type, *Rotula rumphii* Agassiz, *l.c.* = *Echinus orbiculus* Linné, 1758. Sys. Nat., ed. 10, p. 666.

Test very flat, of small or moderate size, with 8 or more marginal slits in posterior half of test-margin.

1. *Rotula deciesdigitata*.

Echinodiscus deciesdigitatus Leske, 1778. Add. ad Klein, p. 145.

Rotula deciesdigitata H. L. Clark, 1914. Mem. M.C.Z., 46, p. 78.

Agassiz, 1841. Mon. Ech., Mon. Scut., pl. II, figs. 1-10 (as *R. angusti*).

Test with a lunule in each anterior ambulaerum.

20 specimens, of which 18 are bare and 7 have no locality labels. Localities represented are: West Africa; Lagos. The specimens from West Africa and Lagos were labelled *Rotula digitata*, and 3 from an unknown locality were named *Echinodiscus bisperforatus*.

Specimens 50 mm. or less in length have only the two groups of 4 lobes each on the posterior margin, but these are present and perfectly formed in the smallest specimen, 22 × 21 mm., in which the lunules are also present; thus the series throws no light on the formation of the lunules. The smallest specimen has no genital pores, but they are distinct in an individual 28 × 28 mm. The largest specimens, 77 × 79 mm., have 2 lobes on each side of test above the posterior interambulacral slits, so that there are 12 lobes altogether.

2. *Rotula orbiculus*.

Echinus orbiculus Linné, 1758. Sys. Nat., ed. 10, p. 666, no. 17 a.

Rotula orbiculus Meissner, 1904. Bronn's Thierreich, 2, p. 1384.

Agassiz, 1841. Mon. Ech., Mon. Scut., pl. I (as *Rotula rumphii*).

Test without lunules.

49 specimens, of which 26 are bare and 16 are without locality labels. Localities represented are: Cape Verde Islands (*Crossland*); West Africa; Gambia; mouth of Gambia River; Angola, Loanda, Praia de Bisja; Ascension Island. These are all labelled either *R. dentata* or *R. digitata*.

The specimens from Gambia are small, but 2 (one especially) show an additional lobe on each side, making 12 altogether. A large specimen without locality has 12 lobes well marked, and an additional lobe on each side plainly indicated. The specimens from Loanda are very fine; the largest is 74 × 73 mm. The record from Ascension is interesting.

The 9 individuals from Gambia show growth changes from a stage 6.5 × 5.5 mm. with no genital pores and only 8 small marginal lobes, up to the adult form with 10 distinct lobes and 2 others indicated. Specimens 11 mm. long show the

genital pores, but 10 lobes are not evident until the animals are 17 or 18 mm. long. Occasionally one sees an asymmetrical specimen with 9 or 11 lobes, but as a rule bilateral symmetry is well maintained.

Suborder 2. *ECHINONEINA*, Hawkins.¹

Interambulacrum 5 not essentially different orally from the other interambulacra. Ambulacra narrow, not at all petaloid, composed of triad groups similar to those of the Echinidae; pore-pairs uniserial with minute pores.

Family 1. ECHINONEIDAE, Wright.

Peristome oblique; periproct on oral surface close to mouth.

This very primitive family, which Hawkins is inclined to view as the only surviving group of Holoctypoids, is represented in the collection by all 3 of the previously known species and by 1 apparently new one. There are only 2 recent genera.

1. ECHINONEUS.

Leske, 1778. Add. ad Klein, p. 109.

Type, *Echinoneus cyclostomus* Leske, 1778. Add. ad Klein, p. 109.

Poriferous areas depressed: all pore-pairs in peripodia.

1. *Echinoneus abnormalis*.

De Loriol, 1883. Mem. Soc. Phys. Hist. Nat. Genève, 28, no. 8, p. 41, pl. V, figs. 2-2 d (as *E. abnormis*).

Primary tubercles perforate; colour usually more or less olive or greenish, sometimes light brown when dry.

One specimen from Rotuma.

This is a superb example of this rare and remarkable species, hitherto known only from Mauritius, Hawaii and the Society Islands. It measures $36 \times 29 \times 18$ mm., and the colour in alcohol is quite brown, with no trace of either green or red; when dry the colour is greyish-brown. As Hawkins suggests in a letter, the perforate condition of the tubercles in this species is what might naturally be expected if the Echinoneidae are Holoctypoids, and it is the imperforate condition of the tubercles in the common *Echinoneus* which should be termed 'abnormal'!

¹ I have made use here of a name suggested to me by Hawkins *in litt.*, and as the recognition of the real affinity of the group to the Holoctypina is due to his published work, there can be no objection to associating his name with the suborder.

2. *Echinoneus abruptus* sp. nov. PLATE X, figs. 1-3.

Test short, wide and rather high, highest posteriorly and thence obliquely truncate, with rounded margins. Length, 27 mm., width 24 mm., height 15 mm. Abactinal system markedly posterior, 16 mm. from anterior end of test; genital pores 4. Tubercles imperforate. Ambulacra moderately wide, III widest (5 mm.), I and V narrowest (3 mm.). Interambulacrum V very narrow, only 7 mm. at ambitus; interambulacra I and IV are 12.5 mm. and II and III are 13. Peristome nearly central, oblique, short and wide. Periproct only 2 mm. posterior to it, oval, about 5.5×3.5 mm. Pedicellariae fairly numerous, not peculiar, but essentially as in *E. cyclostomus*. Colour, pale wood-brown.

Zanzibar (*Crossland*). One specimen.

This may be an abnormal individual of *E. cyclostomus*, but it seems more probable that it is a distinct species. The narrow posterior interambulacrum and the markedly posterior position of the apical system are characteristic; but whether these characters are constant remains to be seen. Further material from Zanzibar is greatly to be desired.

3. *Echinoneus cyclostomus*.

Leske, 1778. Add. ad Klein, p. 109; Westergren, 1911. Mem. M.C.Z., 39, no. 2, pls. I-V.

Test very variable in form but abactinal system central or anterior; interambulacrum V not conspicuously narrower than the other interambulacra; ambulacra all subequal in width.

84 specimens, of which 65 are bare and 37 are without locality labels. Localities represented are: West Indies; Jamaica; Barbuda; St. Vincent; Ascension Island; East Africa, Mombasa, shoal (*Crossland*); Natal, Scottsburg; Mauritius; Rodriguez; Maldives Islands, Minikoi; Ceylon; Andaman Islands; Torres Strait; North Australia, Port Essington; Queensland, Coloondra; South Seas; Loyalty Islands; Funafuti Lagoon, 18 fms.

The most interesting is the fine specimen from Scottsburg, Natal, as *Echinoneus* has not been recorded hitherto from south of Zanzibar. The largest test in the collection is labelled 'West Indies' and measures $44 \times 36 \times 21$ mm.; this seems to be the largest specimen on record. The specimen from Funafuti, $31 \times 28 \times 17$ mm., has a peculiar appearance due to the presence of little flattened areas here and there, the cause of which is hard to surmise.

2. MICROPETALON.

A. Agassiz and Clark, 1907. Bull. M.C.Z., 50, p. 251.

Type, *Micropetalon purpureum* A. Agassiz and Clark, 1907, *l.c.*

Poriferous areas flush with the test; pore-pairs of mid-zone without peripodia.

1. *Micropetalon purpureum*.

A. Agassiz and Clark, 1907. Bull. M.C.Z., 50, p. 251. Westergren, 1911. Mem. M.C.Z., 39, no. 2, pl. XXIX.

Test oral, flattened above and beneath; colours dirty-whitish, white and rich purple.

2 specimens from Macclesfield Bank, 30-40 fms., labelled *Echinoneus cyclostomus*.

This species was hitherto known from the holotype, from the Hawaiian Islands. Hawkins (1920, Trans. Roy. Soc. London (B) 209, p. 444) has expressed the opinion that *Micropetalon* may be a 'post-larval stage' and he is doubtful as to its 'systematic validity'. These doubts, I think, are ill-founded. There is nothing youthful about the solid test of *Micropetalon*, and the well-developed genital pores indicate sexual maturity. But the genus retains youthful (or primitive) characters. The Macclesfield Bank specimens are considerably larger than the type; one is $19 \times 16 \times 10$ mm. and the other $24 \times 20 \times 11$. The tests are whitish with a purplish cast above, quite purple below, especially on peristome and periproct: poriferous areas purple; abactinal system purplish. Spines white. On each specimen, but especially the smaller, are 10 or more large globiferous pedicellariae, which appear as conspicuous deep purple spots, as the test beneath and near them, as well as their own tissues, is rich purple. The valves of these pedicellariae are similar to those of *Echinoneus*, but there are only 3 big teeth on each side, near the tip.

Suborder 3. NUCLEOLITINA, Hawkins.¹

Interambulacrum 5 not essentially different orally from the other interambulacra. Ambulacra petaloid or at least sub-petaloid, in part of simple plates, in part the plates are compound, of 3 elements. Pores of petals, dissimilar.

Family 1. NUCLEOLITIDAE, Gregory.

Ambulacra and interambulacra not disposed to form a 'floscelle' around mouth, no 'bourrelets' and no 'phyllodes' being developed.

¹ Hawkins did not use the termination *-ina*, but I have adopted it for the sake of uniformity with other groups of the same rank; using the name, moreover, as equivalent to Hawkins's *Nucleolitoida*.

Only a single recent genus is known in this family and that is monotypic.

1. APATOPYGUS.

Hawkins, 1920. Geol. Mag., **57**, p. 396.

Type, *Nucleolites recens* Milne-Edwards, 1836. Cuvier's Regne Animal, Illus. Ed., Zoophytes, pl. XIV, fig. 3.

Test depressed, subquadrate, with greatest width back of apex; peristome transversely elliptical; periproct longitudinally elliptical, on the anterior wall of a deep abactinal depression midway between apex and ambitus.

1. *Apatopygus recens*.

Nucleolites recens Milne-Edwards, 1836. Cuvier's Regne Animal, Illus. Ed., Zoophytes, pl. XIV, fig. 3.

Apatopygus recens Hawkins, 1920. Geol. Mag., **57**, p. 396. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XXI b, figs. 1 and 2 (as *Echinobrissus recens*).

Size moderate; abactinal system anterior to centre; colour, when in alcohol or dried therefrom, more or less green.

5 specimens, of which 2 are bare, 1 is without locality label, 3 are from New Zealand, and 1 is said to be from 'Madagascar'.

The recent work of Hawkins (1920, Geol. Mag., **57**, pp. 393-401) and Mortensen (1921, Vid. Medd., **73**, pp. 184-92) makes it impossible to place this remarkable relict in the Spatangina or even in the Cassidulina. It seems to be the sole survivor of its suborder. Mortensen collected living material but tells us nothing of the habits (when adult) or of the colour in life, though he mentions that specimens turn green in alcohol; perhaps the inference may be drawn that the colour is a red-brown like that of many Clypeastroids.

The specimen labelled 'Madagascar' is a small bare test; no doubt it came from New Zealand. It seems to be the specimen upon which the record for Madagascar in Agassiz's 'Revision' is based.

Suborder 4. CASSIDULINA, Hawkins.¹

Interambulacrum 5 not essentially different from the others orally. Ambulacra more or less petaloid abactinally, with pores similar and normally conjugate.

Family 1. CASSIDULIDAE, Agassiz.

Ambulacra and interambulacra disposed to form a 'floscelle' around mouth by development of 'phyllodes' and 'bourrelets'. Periproct near or above margin.

¹ Here again I am using the form for the group name suggested to me by Hawkins *in litt*.

This family is composed of a number of genera ranging from the Jurassic to the present day, but there are only a few living species. The inter-relationships of the extinct and living genera need further elucidation, for *Oligopodia* and *Echinolampas* represent two obviously divergent types.

There are representatives of 11 species and 4 genera among the recent Echinoidea in the British Museum, but most of the species fall in *Echinolampas*, using that genus in a broad sense to include *Palaeolampas*. I have little doubt that a careful revision of recent and fossil Echinolampads will establish *Palaeolampas* and several other valid genera, but until such a revision is made, it seems best to include *Palaeolampas crassa* in *Echinolampas*.

1. RHYNCHOLAMPAS.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 270.

Type, *Cassidulus cariboeorum* Lamarek, 1801. Anim.s. Vert., p. 349.

Periproct in a depression above ambitus, wider than long.

1. *Rhyncholampas cariboeorum*.

Cassidulus cariboeorum Lamarek, 1801. Anim. s. Vert., p. 349.

Rhyncholampas cariboeorum A. Agassiz, 1869. Bull. M.C.Z., 1, p. 270. 1872, Rev. Ech., pt. 1, pl. XV, figs. 1-4 (as *Rhynchopygus cariboeorum*).

Median actinal area deeply pitted and sculptured; colour white, yellowish, or pale brown.

29 specimens, of which 21 are bare and 4 are without locality labels. Localities represented are: Bahama Islands, Nassau; St. Thomas; Antigua, Long Island; Barbuda.

This is a very fine lot of a rare and little known species. Most of the specimens are 12 mm. in length, but a fine one from Barbuda is 27 mm. long, 21 mm. wide, and 12 mm. high. One from Long Island is somewhat deformed at the rear end. That from Nassau is labelled '*Nucleolites occidentalis* Bell', and is apparently the type of that species. The 4 specimens without locality label look like the specimen from St. Thomas, and probably were in the same lot.

2. *Rhyncholampas pacifica*.

Pygorrhynchus pacificus A. Agassiz, 1863. Bull. M.C.Z., 1, p. 27.

Rhyncholampas pacificus A. Agassiz, 1869. Bull. M.C.Z., 1, p. 270. 1873, Rev. Ech., pt. 3, pl. XV a, figs. 1 and 2 (as *Rhynchopygus pacificus*).

Median actinal area with shallow pits and little or no

sculpturing; colour pale brown or yellowish, spotted or blotched with dull greenish.

10 specimens, of which 7 are without locality label, 1 is said to be from Panama, and 2 are from Mexico, Acapulco. Those without locality are from the Wyville Thomson collection, and no doubt came (through Agassiz) from Acapulco. Probably the 'Panama' specimen is also from Acapulco.

Although there are authentic records from the Galapagos Islands, Acapulco has been the chief source of supply for this species. The largest of the present series is $58 \times 48 \times 27$ mm.

2. OLIGOPODIA.

Duncan, 1889. Jour. Linn. Soc., Zool., 23, p. 176.

Type, *Nucleolites epigonus* v. Martens, 1865. Monatsb. Berlin Akad. Wiss., p. 143.

Periproct in a furrow at posterior end of test, longer than wide; long diameter of mouth longitudinal; vertical diameter of test half horizontal diameter, or less.

1. *Oligopodia epigonus*.

Nucleolites epigonus v. Martens, 1865. Monatsb. Berlin Akad. Wiss., p. 143. A. Agassiz, 1873. Rev. Ech., p. 3, pl. XIX b, figs. 4-6.

Oligopodia epigonus Duncan, 1889. Jour. Linn. Soc., Zool., 23, p. 176.

Test broadly rounded in front; colour whitish, pale grey, or very light brown.

8 specimens from Lord Howe Island, all bare tests, bleached, and fragile.

Apparently this little known species is fairly common at Lord Howe Island, so that the possibility of working out its life-history is evident. Such a piece of work is greatly to be desired, especially since Mortensen's discovery of the lantern in *Apatopygus*. These specimens are small, the largest only $17 \times 15.5 \times 8.5$ mm. They have the appearance of having been washed up on the beach after death.

3. HYPSELOLAMPAS.

H. L. Clark, 1917. Mem. M.C.Z., 46, p. 104.

Type, *Catopygus recens* A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 204.

Periproct more or less circular; test very high, its vertical diameter three-fourths of the horizontal or more.

1. *Hypselolampas recens*.

Catopygus recens A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 204.

1881, *Challenger* Ech., pl. XX, figs. 17-21.

Hypselolampas recens H. L. Clark, 1917. Mem. M.C.Z., 46, p. 104.

Test ovoid, high; abactinal system anterior, with only 3 genital pores; periproct posterior at upper end of furrow.

2 specimens, bare tests, from near the Kei Islands, *Challenger* St. 192, 129 fms., mud.

Only bare tests of this remarkable form were taken, and the *Challenger* specimens are still the only ones known, excepting only a 'very young specimen' which Mortensen (1923, Vid. Medd., 76, p. 66) records from essentially the same locality as *Challenger* St. 192. One specimen is $41 \times 33.5 \times 30$ mm. and the other is $43 \times 35 \times 30$ mm.

4. *ECHINOLAMPAS*.

Gray, 1825. Ann. Phil., 26, p. 429.

Type, *Echinanthus ovatus* Leske, 1778. Add. ad Klein, p. 127.

Periproct at or below ambitus, not in a groove or depression; longitudinal diameter of test greater than transverse; mouth anterior.

1. *Echinolampas alexandri*.

De Loriol, 1876. Mém. Soc. Phys. Hist. Nat. Genève, 24, p. 660.

H. L. Clark, 1917. Mem. M.C.Z., 46, pl. CLIII, figs. 3 and 4.

Poriferous areas abactinally shortened, not reaching nearly to ambitus; ambulacra moderately wide, more or less petaloid abactinally; tuberculation rather coarse, median areas of petals II and IV with not more than 8 (usually 4-8) vertical series of primary tubercles.

4 specimens, of which 2 are bare and 1 has no locality label; 2 are from Mauritius and 1 from the Amirantes, 160-209 fms. Of the 4, 3 are labelled *E. oviformis*.

The very typical bare test from Mauritius is $68 \times 61 \times 42$ mm., and the one without locality is $59 \times 52 \times 29.5$ mm. The other Mauritius specimen is a very fine one, $73 \times 65 \times 38$ mm., and that from the Amirantes is even finer, $81 \times 68 \times 37$ mm., and dull yellow in colour. It will be noted that the height of the test varies from 0.45 to 0.62 of the length. This material tends to confirm the validity of *E. alexandri*.

2. *Echinolampas crassa*.

Palaeolampas crassa Bell, 1880. Proc. Zool. Soc. London, p. 43, pl. IV.

Echinolampas crassa H. L. Clark, 1917. Mem. M.C.Z., 46, p. 113.

Test nearly as wide as long, not gibbous posteriorly ; ambulacra wide ; poriferous areas abactinally long, reaching nearly or quite to ambitus ; anterior poriferous areas of ambulacra II and IV only 4-10 pore-pairs shorter than posterior.

12 specimens, of which 2 are bare. Localities represented are : Cape of Good Hope ; False Bay, Kromhout, 14 fms. ; ' India '.

The large bare specimen, labelled India, is obviously the type of the species and certainly came from South Africa, not India. Some at least of the South African specimens were referred to by Bell in his South African report (1904), but he gave no measurements ; one of the finest is $83 \times 77 \times 35$ mm., which is much flatter than usual.

3. *Echinolampas depressa*.

Gray, 1851. Proc. Zool. Soc. London, p. 38. A. Agassiz, 1883. Mem. M.C.Z., 10, no. 1, pl. XVI.

Poriferous areas abactinally shortened and unequal ; inner poriferous areas of ambulacra I and V about half as long as outer or even less ; tuberculation fine.

1 specimen from off Grenada, B.W.I., 92 fms.

This is a very typical specimen taken by the *Blake* at St. 253.

4. *Echinolampas koreana* sp. nov. PLATE X, figs. 4 and 5.

Test relatively high, 52 mm. long, 43 mm. wide, and 31 mm. in height. Abactinal system only 17 mm. from anterior margin of test, closely tuberculated, with 4 large genital pores. Petals I and V with outer poriferous area about 21 mm. long, with 35 or more pore-pairs, and inner only about 12 mm. with 24 or more pore-pairs. Petals II and IV, with posterior poriferous area about 18 mm. long with 36 or more pore-pairs and the anterior about 11 mm. long with 23 or more pore-pairs. Petal III has the left-hand poriferous area about 17 mm. long, with some 30 pore-pairs, and the right-hand area a little shorter, but with about the same number of pore-pairs. Tuberculation rather fine, about 50 primary tubercles to 25 sq. mm. ; 4-6 longitudinal series (but very irregular) in each petal. Periproct somewhat sunken, below ambitus, and overhung by test on its upper margin. Peristome very small, only 3-4 mm. wide, very deeply sunken. Spines and pedicellariae unknown. Colour dull greyish-buff with poriferous areas more or less purple.

Korean Strait, eastern channel, $33^{\circ} 14' N.$, $128^{\circ} 55' E.$, 40 fms. May 1876 (*W. P. Sladen*). One specimen.

This species is intermediate between the forms with high tests and broad petaloid ambulacra and those with low tests and narrow, scarcely petaloid areas. In coloration it is so much like *E. sternopetala* that it might be taken for a very high

example of that species, but the finer tuberculation, wider petals, smaller and more deeply sunken mouth, and differences in the poriferous areas are characters which cannot be ignored, unless *E. sternopetala* is much more variable than we have any reason to think.

5. *Echinolampas ovata*.

Echinanthus ovatus Leske, 1778. Add. ad Klein, p. 127.

Echinolampas ovata Döderlein, 1906. *Valdivia* Ech., p. 240.

H. L. Clark, 1917. Mem. M.C.Z., 46, pl. CLIII, figs. 1 and 2.

Test rather high, with tuberculation close and fine; poriferous areas of I and V markedly unequal, the outer longer.

10 specimens, of which 9 are bare and 5 are without locality labels. Localities represented are: Indian Ocean; India, Tuticorin; West Australia, Dampier Archipelago, Lewis Island.

One of the specimens from Tuticorin is in good condition, rather bright buff in colour; it is $41 \times 36 \times 26$ mm. in size.

6. *Echinolampas richardi*.

Desmoulins, 1837. *Études Ech.*, Tab. Syn., p. 340. H. L. Clark, 1917. Mem. M.C.Z., 46, pl. CLIII, figs. 9 and 10.

Test flattened, the height about half diameter, or less; tuberculation fine; poriferous areas of I and V more or less nearly equal, or the inner longer.

1 specimen, bare, labelled '*Echinolampas*. St. Vincents'.

This is a typical specimen, $56 \times 52 \times 26$ mm. Presumably 'St. Vincents' is St. Vincent Island in the Cape Verde group.

7. *Echinolampas sternopetala*.

A. Agassiz and Clark, 1907. Bull. M.C.Z., 51, p. 130. H. L. Clark, 1917. Mem. M.C.Z., 46, pl. CLIII, figs. 5-7.

Test low and wide; ambulacra narrow, with abactinal poriferous areas not very distinct though tinted with violet or purple; pores of a pair rather close together; tuberculation rather coarse and sparse.

2 specimens, 1 from *Challenger* St. 192, near the Kei Islands, 129 fms., mud, and the other from Japan, Misaki. The *Challenger* specimen is labelled *E. oviformis*.

Both of these specimens are larger than the original types, and they show that what was thought to be an important specific character (the relative distance between the pores of a pair and the pore-pairs) does not hold in adults. In the Misaki specimen which is $67 \times 57 \times 28$ mm., these two distances are about equal, but in the *Challenger* specimen, which is $81 \times 72 \times 39$ mm., the pores are over a millimetre apart and the pore-pairs are distant from each other 0.75-0.80 mm. In

both specimens the characteristic tridentate pedicellariae are present, although pedicellariae are on the whole rather few. In the larger specimen the largest tridentate pedicellariae found had valves scarcely 0.60 mm. in length. The Misaki specimen is bright buff with the abactinal poriferous areas lavender; in petal I the inner poriferous area is unusually long, nearly 18 mm., and the outer is 26; in II the posterior area is 26 and the anterior 17 mm.; and in III the left-hand area is 21 and the right 27 mm. The *Challenger* specimen is yellow with a greenish tinge; the purple of the poriferous areas is rather faint; in petal I the inner poriferous area is about 16 mm. long and the outer is 37; in II the posterior area is 33 and the anterior 18 mm.; in III the left-hand area is 23 and the right 35 mm., a very striking disparity.

Suborder 4. *URECHININA*, nom. nov.

Interambulacrum 5 modified orally to form a sternum, but having the labrum followed by a single plate.

This group has long been recognized as the meridosternatus *Spatangina*, but has not been set apart as a group equivalent to the suborders of *Exocycloida* here recognized. In view of the difficulty of deriving meridosternatus forms from those which are amphisternatus, it seems better to let each group rank as a suborder, and I have based the name of the one now under consideration upon the best known of its more primitive genera. The *Urechina* are deep-water forms and, excepting *Urechinus* and *Pourtalesia*, specimens are rare. Satisfactory material for study is very scanty even in the largest museums.

Family 1. *URECHINIDAE*, Lambert.

Mouth horizontally placed on oral surface of test; interambulacra all meridoplacous (i.e. in each one the primordial interambulacral plate is followed by a single plate).

This family is represented only poorly in the Museum, as except for specimens of the best known species, the material is largely in fragments. Nearly all of it has been gone over by Mortensen, and I find little to add to what he has published (1907, *Ingolf* Ech., pt. 2) except in connexion with *U. clypeatus*.

1. *URECHINUS*.

A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 207.

Type, *Urechinus naresianus* A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 207.

Periproct at or below ambitus, not in a depression; test only moderately high, not flexible, but brittle.

1. *Urechinus clypeatus*.

Cystechinus clypeatus A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 208.

Urechinus clypeatus H. L. Clark, 1917. Mem. M.C.Z., **46**, p. 122. (No figures available.)

Genital pores 4; valves of globiferous pedicellariae with only a single terminal point, the blade turned inward but not bent.

Fragments from *Challenger* St. 133, South Atlantic, 35° 41' S., 20° 55' W., 1,900 fms., globigerina ooze, and from *Challenger* St. 334, South Atlantic, 35° 45' S., 18° 31' W., 1,915 fms., globigerina ooze.

Mortensen has definitely restricted the name *U. clypeatus* to the South Atlantic form, and has shown that the additional fragments recorded from St. 205, in the China Sea, are certainly not fragments of a *Urechinus*. Mortensen states that 'no trace of the apical system' is found among the fragments from St. 205, but I found among them the very fragment from which the *Challenger* figure (pl. XXXV b, fig. 10) was made; the only criticism I would make of that figure is that the ocular pores in plates I and V are incorrectly depicted as set off in tiny plates by themselves. Mortensen evidently did not see this fragment. This abactinal system is more like that of a Urechinid than that of any of the Pourtalesiidae, but the pedicellariae certainly indicate that the specimen from St. 205 belongs to the latter family.

2. *Urechinus naresianus*.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 207. 1881, *Challenger* Ech., pl. XXIX, figs. 1-4, and pl. XXX.

Genital pores 3; globiferous pedicellariae with the terminal opening surrounded by about 7 long slender teeth.

75 specimens, mostly bare, besides numerous fragments. Localities represented are: North Atlantic, off Cape Cod, *Blake* St. 308, 1,242 fms., fine dark grey mud; Central Atlantic, *Challenger* St. 16, 20° 39' N., 50° 33' W., 2,435 fms., globigerina ooze; Cape of Good Hope; South Indian Ocean, *Challenger* Sts. 146, 46° 46' S., 45° 31' E., 1,375 fms., globigerina ooze, 147, 46° 16' S., 48° 27' E., 1,600 fms., globigerina ooze, and 158, 50° 1' S., 123° 4' E., 1,800 fms., globigerina ooze; off the coast of Chile, *Challenger* St. 302, 42° 43' S., 82° 11' W., 1,450 fms., globigerina ooze.

A very large proportion of these are young and in poor condition. They show the well-known diversity in form and in the condition of the fasciole. Among the specimens from St. 147, 4 are distinguished by the very well-developed fasciole; the largest of these is 48 mm. long, 41 mm. wide, 21 mm. high posteriorly and 18 mm. high near the anterior end; usually the fasciole has disappeared long before so large

a size is reached. Another peculiarity of these 4 specimens is that the periproct is somewhat sunken. Mortensen (1907, *Ingolf* Ech., pt. 2, p. 44) is sure that the specimens from St. 158 are not *U. naresianus*. I cannot find in them a globiferous pedicellaria, but in every other detail they agree with *U. naresianus*; is it possible that the peculiar globiferous pedicellaria that Mortensen found was adventitious? Mortensen is also sceptical about the specimens from St. 302; this material is fragmentary and poor, and no satisfactory conclusion can be reached.

3. *Urechinus wyvillii*.

Cystechinus wyvillii A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 208. 1881, *Challenger* Ech., pl. XXIX a.

Genital pores 4; globiferous pedicellariae with short tubular blade, and 1 tooth on each side of terminal opening.

11 specimens and many fragments from the *Challenger* collection: Sts. 146, 147, and 158 (see above under *U. naresianus*); St. 296, west of Chile, 38° 6' S., 88° 2' W., 1,825 fms., red clay; St. 299, 33° 31' S., 74° 43' W., 2,160 fms., grey mud; St. 300, 33° 42' S., 78° 18' W., 1,375 fms., globigerina ooze.

This species is so near to *U. naresianus* that when they occur at the same station young specimens are very difficult to separate, unless globiferous pedicellariae are available. The best specimen, although it is nearly bare, is from St. 158. The fragments from St. 299 are in poor condition and their identity is doubtful.

2. PILEMATECHINUS.

A. Agassiz, 1904. Mem. M.C.Z., 31, p. 165.

Type, *Cystechinus rathbuni* A. Agassiz, 1898. Bull. M.C.Z., 32, p. 79.

Test very high, the vertical diameter 0.70–0.90 of horizontal; all plates around mouth very small; test thin, but leathery and flexible.

1. *Pilematechinus vescica*.

Cystechinus vescica A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 209. 1881, *Challenger* Ech., pl. XXXV.

Pilematechinus vescica A. Agassiz, 1904. Mem. M.C.Z., 31, p. 232.

Genital pores 3; lower margin of periproct just above ambitus.

3 specimens from *Challenger* Stations: St. 153, Antarctic Ocean, 65° 42' S., 79° 49' E., 1,675 fms., mud; St. 298, west of Chile, 34° 7' S., 73° 56' W., 2,225 fms., grey mud; St. 299, 33° 31' S., 74° 43' W., 2,160 fms., grey mud.

Family 2. CALYMNIDAE, Mortensen.

Mouth horizontally placed on oral surface of test; interambulacra 2 and 3. amphiplacous (i.e. the primordial interambulacral plate is followed by 2 plates); ambulacral pores all simple.

This family includes but a single genus and species. It is represented in the Museum by fragments only, and no other specimens are yet known. It is questionable whether the presence of simple ambulacral pores is in itself sufficient for maintaining a separate family.

1. CALYMNE.

Wyville Thomson, 1877. *Voy. Challenger*: The Atlantic, 1, p. 397.

Type, *Calymne relictæ* Wyville Thomson, 1877. *Voy. Challenger*: The Atlantic, 1, p. 397.

Test nearly elliptical in outline, with a narrow marginal fasciole; genital pores 2; peristome markedly anterior.

1. *Calymne relictæ*.

Wyville Thomson, 1877. *Voy. Challenger*: The Atlantic, 1, p. 397.

Test wide, flattened above, but with a low slightly rounded keel on posterior part of oral surface. Colour of test and spines pale green.

Large fragments from *Challenger* St. 54, north of the Bermudas, 2,650 fms., blue mud.

These fragments are labelled 'Fayal. 2650 fms.', and that locality is also printed in the *Challenger* Report by Agassiz. But the narrative and the summary of results of the *Challenger* show that the true locality was not very far from the Bermudas.

Family 3. POURTALESIIDAE, Lovén.

Test more or less elongate and often of very unusual form, with the mouth vertical at the end of an oral furrow or invagination.

This family undoubtedly includes the most bizarre and the most highly specialized sea-urchins. Owing to their occurrence in very deep water, they are little known to the general zoologist, and many of the species are imperfectly known even to the specialist. Fifteen or more species have been described, and ten of these are in the Museum collection, but five are represented only by fragments, and of the others two only are represented by more than a single whole specimen. This poor condition of the available material is due to the great fragility of the tests and the fact that they must be collected and brought to the surface from great depths by so clumsy and rough an instrument as the trawl, or the scarcely better dredge.

1. ECHINOCREPIS.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 206.

Type, *Echinocrepis cuneata* A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 206.

No subanal rostrum ; tube-feet near mouth not peculiar ; no fascioles ; test widest anteriorly ; apical system compact.

1. Echinocrepis cuneata.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 206. 1881, *Challenger* Ech., pl. XXVII.

Colour violet-brown ; spines brownish-yellow ; outline ' that of a truncated cone with rounded corners and a deep re-entering angle ' in anterior margin.

A specimen from *Challenger* St. 147, near the Crozet Islands, 1,600 fms., globigerina ooze.

According to the *Challenger* Report, two specimens of this extraordinary animal were taken at St. 147, but only one is now in the Museum. The whereabouts of the other is not known ; it is not in the Museum of Comparative Zoölogy.

2. SPATAGOCYSTIS.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 206.

Type, *Spatagocystis challengerii* A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 206.

Subanal rostrum small, overhung by test.

1. Spatagocystis challengerii.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 206. 1881, *Challenger* Ech., pl. XXVI.

Test rounded triangular, widest anteriorly, rather low ; oral invagination not very deep.

12 specimens from *Challenger* collection : St. 147, near the Crozet Islands, 1,600 fms., globigerina ooze ; St. 157, south-eastern Indian Ocean, 1,950 fms., diatom ooze.

The largest of these specimens is from St. 157 and measures $63 \times 45 \times 30$ mm. Like several other specimens it is labelled '*Pourtalesia*'. Agassiz says in the *Challenger* Report, 'subanal fasciole indistinct', and in his figures, both in the *Challenger* Report and in Panamic Deep Sea Echini (1904, Mem. M.C.Z., **31**, pls. LXX and LXXI), there is no indication whatever of such a fasciole. But in at least half the specimens, including some from both stations, the subanal fasciole is well developed ; probably it is normally present in undamaged specimens.

3. CERATOPHYSA.

Pomel, 1883. Class. Meth. Ech., p. 40.

Type, *Pourtalesia ceratopyga* A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 205.

Test stout, not greatly elongated, widest anteriorly : dorsal plates of interambulacrum 5 alternating.

1. *Ceratophysa ceratopyga*.

Pourtalesia ceratopyga A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 205. 1881, *Challenger* Ech., pl. XXVIII.

Ceratophysa ceratopyga Pomel, 1883. Class. Meth. Ech., p. 40.

Dark claret, fading to light violet : test rather low and wide, its width at anterior end nearly equal to 0.65 of test length : anal rostrum rounded.

1 specimen and fragments of 2 or more others, from the *Challenger* collection : St. 157, south-eastern Indian Ocean, 1,950 fms., diatom ooze ; St. 298, west of Chile, 2,225 fms., grey mud ; St. 299, west of Chile, 2,160 fms., grey mud.

Only the individual from St. 157 is sufficiently intact to show the general form in life.

2. *Ceratophysa rosea*.

Pourtalesia rosea A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 206.

Ceratophysa rosea Pomel, 1883. Class. Meth. Ech., p. 40. (No suitable figures available.)

General appearance of test unknown, but subanal rostrum is laterally compressed and truncate.

Fragments from *Challenger* St. 272, Central Pacific, 2,600 fms., radiolarian ooze.

Probably no other sea-urchin has been given a name on the basis of such poor material as this, and it is almost a pure assumption to place it in *Ceratophysa* ; but Mortensen has found ophicephalous pedicellariae on a fragment made up chiefly of the subanal rostrum, and these permit the placing of this species in the same genus as *C. ceratopyga*.

4. HELGOCYSTIS.

Mortensen, 1907. *Ingolf* Ech., pt. 2, p. 82.

Type, *Pourtalesia carinata* A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 205.

Test relatively high and stout, widest behind the middle : dorsal plates of interambulacrum 5 alternating ; subanal rostrum conspicuous.

1. *Helgocystis carinata*.

Pourtalesia carinata A. Agassiz, 1879. Proc. Amer. Acad., p. 205.
1881, *Challenger* Ech., pl. XXVIII a.

Helgocystis carinata Mortensen, 1907. *Ingolf* Ech., pt. 2, p. 82.

Genital pores 4; colour. in alcohol, light claret. with light-coloured spines.

Fragments from the *Challenger* collection: St. 147, near the Crozet Islands, 1,600 fms., globigerina ooze; St. 157, south-eastern Indian Ocean, 1,950 fms., diatom ooze; St. 298, west of Chile, 2,225 fms., grey mud.

5. POURTALESIA.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 272.

Type, *Pourtalesia miranda* A. Agassiz, 1869. Bull. M.C.Z., 1, p. 272.

Test fragile, more or less elongated, but not excessively so; dorsal plates of interambulacrum paired: bival ambulacra discontinuous.

1. *Pourtalesia alcocki*.

Koehler, 1914. Ech. Indian Mus.: Spat., p. 8, pl. I, figs. 1-14.

Subanal rostrum large, with sides nearly or quite parallel, and tip truncate, more or less elevated; genital plates not completely fused together.

1 specimen from Cape of Good Hope, off Cape Point, 46 miles, 900 fms.; labelled *Pourtalesia carinata*.

This is a very good example of *P. alcocki*, 35 mm. long by 16.5 mm. wide; the colour is dark purple.

2. *Pourtalesia hispida*.

A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 204. 1881, *Challenger* Ech., pl. XXII, figs. 6-19.

Subanal rostrum small, low, slightly tapering, its length much less than diameter of periproct.

Fragments of 3 or more specimens from the *Challenger* collection; 2 from St. 147, near the Crozet Islands, 1,600 fms., globigerina ooze; 1 or more from St. 156, Antarctic Ocean, 1,975 fms., diatom ooze.

3. *Pourtalesia jeffreysi*.

Wyville Thomson, 1874. Phil. Trans. Roy. Soc., 164, p. 747.
Mortensen, 1907. *Ingolf* Ech., pt. 2, pl. V, figs. 13, 14, 16-19, 21 and 23.

Subanal rostrum large, with sides converging towards the rounded and little elevated tip; test about half as wide as long; posterior end of test (dorsal keel) overhangs periproct.

4 specimens from Norwegian North Atlantic St. 295, 1,110 fms., biloculina clay. With 2 of the specimens there is also a label 'St. 297', which was in 1,280 fms. on the same sort of bottom.

4. *Pourtalesia laguncula*.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 205. 1881, *Challenger* Ech., pl. XXXI, figs. 1-6.

Subanal rostrum large, with sides nearly or quite parallel, and tip truncate and elevated; genital plates completely fused; size moderate; ophicephalous pedicellariae common.

1 specimen and numerous fragments from the *Challenger* collection: St. 168, off New Zealand, 1,100 fms., grey ooze; St. 169, off New Zealand, 700 fms., grey ooze; St. 191, near the Kei Islands, 800 fms., mud; St. 232, off Japan, 345 fms., sandy mud. There are also fragments of a *Pourtalesia*, labelled *P. laguncula*, from St. 244, western Pacific, 2,900 fms., which Mortensen is very sure should not be referred to this species. I am inclined to agree with him, but the material is too bad for a satisfactory conclusion.

The only good specimen is from St. 232. The *Albatross* explorations showed that *P. laguncula* is very common round Japan in 120-749 fms.

6. ECHINOSIGRA.

Mortensen, 1907. *Ingolf* Ech., pt. 2, pp. 68 and 82.

Type, *Pourtalesia phiale* Wyville Thomson, 1873. Depths of the Sea, p. 90, as interpreted and limited by A. Agassiz, 1881. *Challenger* Ech., p. 138.

Test fragile, excessively elongated, the bival ambulacra continuous; subanal rostrum conspicuous.

1. *Echinosigra phiale*.

Pourtalesia phiale (? Wyville Thomson, 1873. Depths of the Sea, p. 90. 1874, Phil. Trans. Roy. Soc., **164**, p. 749). A. Agassiz, 1881. *Challenger* Ech., p. 138.

Echinosigra phiale Mortensen, 1907. *Ingolf* Ech., pt. 2, pp. 68, 82, pl. VI, figs. 1, 2, and 7.

Neck short, its least width nearly 0.20 of test length.

Fragments of a very poor specimen from *Challenger* St. 156, Antarctic Ocean, 1,975 fms., diatom ooze.

This material is almost worthless now, but has some historical interest.

Suborder 5. SPATANGINA, Jackson.

Interambulacrum 5 modified orally to form a sternum; labrum followed by a pair of equal, or nearly equal, large plates.

Family 1. PALAEOSTOMATIDAE, Gregory.

Ambulacra somewhat petaloid abactinally; peripetalous fasciole present; peristome pentagonal, closed by 5 equal triangular plates.

This family is maintained for the single species, whose extraordinary peristome excludes it from all other families. This species is represented in the Museum by a few specimens, but only one is large enough to show the adult characters well.

1. PALAEOSTOMA.

A. Agassiz, 1872. Rev. Ech., pt. 1, pp. 80, 147.¹

Type, *Leskia mirabilis* Gray, 1851. Ann. Mag. Nat. Hist. (2), 7, p. 134.

Test high and wide, with periproct in a depression on abactinal surface, near posterior end.

1. *Palaeostoma mirabilis*.

Leskia mirabilis, Gray, 1851. Ann. Mag. Nat. Hist. (2), 7, p. 134. 1855, Cat. Rec. Ech. Brit. Mus., pl. IV, figs. 4 and 4 a.

Palaeostoma mirabilis A. Agassiz, 1872. Rev. Ech., pt. 1, pp. 80, 147.

Small, oval, white or light-coloured Spatangoids, with the remarkable peristome characteristic of the family.

8 specimens, of which 6 very small ones are from Macclesfield Bank, 35-41 fms., 1 in fragments is from Batavia, and 1 bare test is from Luzon.

The specimen from Luzon is undoubtedly Gray's type. It measures $13.5 \times 11.5 \times 10$ mm., and the figures he gives are just twice natural size, although he does not mention this. The Macclesfield Bank specimens are markedly different from the type, but the differences may be due to their obvious immaturity.

Family 2. AEROPSIDAE, H. L. Clark.

Peristome circular, covered by a membrane with few scattered small plates or none.

This family was instituted for two genera superficially quite unlike, but agreeing in the peculiar character of the peristome. Both are found in the deep sea, and good specimens are rare. The series in the British Museum is very small and affords no new data.

1. AEROPSIS.

Mortensen, 1907. Ingolf Ech., pt. 2, p. 90.

Type, *Aerope rostrata* Norman, 1876. Proc. Roy. Soc. London, 25, p. 212.

Test elongate, more or less cylindrical; mouth flush with ventral surface; ambulacrum III not depressed dorsally.

¹ Although Agassiz attributes the name to Lovén, it is of his own coinage.

1. *Aeropsis rostrata*.

Aerope rostrata Norman, 1876. Proc. Roy. Soc. London, **25**, p. 212.
Aeropsis rostrata Mortensen, 1907. *Ingolf* Ech., pt. 2, p. 90, pl. V,
 figs. 8-10, 15.

Height of test exceeds one-half length; sternum keeled.

2 specimens and fragments of a third: from Davis Strait; Bay of Biscay (*Challenger*); St. 191, Arafura Sea, 800 fms., mud (*Challenger*). The Davis Strait specimen was labelled *Pourtalesia*.

The Davis Strait specimen would seem to be undoubtedly Canon Norman's type, taken in Davis Strait at a depth of 1,750 fms.; this he at first considered to be allied to *Pourtalesia*. The Bay of Biscay specimen is apparently the smaller of the two described and figured in the *Challenger* Report. If there were any proof that the specimen, or rather fragments, from St. 191 is the original of the figures of Agassiz's 'larger specimen', I should not hesitate to list it as *Aeropsis fulva*, for the figures are evidently of that species (see *Challenger* Ech., pl. XXXIII, figs. 1-7, especially 3 and 4), or at least they are not *A. rostrata*. Unfortunately Agassiz did not say where the larger specimen was taken. The specimen from St. 191 is now in hopelessly unidentifiable fragments.

2. *ACESTE*.

Wyville Thomson, 1877. *Voy. Challenger: The Atlantic*, **1**, p. 376.

Type, *Aceste bellidifera* Wyville Thomson, 1877. *Voy. Challenger: The Atlantic*, **1**, p. 376.

Test wide and flattened; mouth vertical; ambulacrum III greatly enlarged and deeply depressed dorsally.

1. *Aceste bellidifera*.

Wyville Thomson, 1877. *Voy. Challenger: The Atlantic*, **1**, p. 376.

A. Agassiz, 1881. *Challenger* Ech., pl. XXXII, figs. 7-11, pl. XXXIII a, figs. 1-7.

Test sloping forward very distinctly from apex; height of anterior end hence much less than posterior; height posteriorly more than half length; sternum and labrum prominent.

1 specimen from *Challenger* St. VIII, Canary Islands, off Gomera, 620 fms., sandy mud and shells; and bare fragments from *Challenger* St. 272, Central Pacific, 2,600 fms., radiolarian ooze.

The specimen from off Gomera is referred to by Thomson in his original description, and hence it is fair to consider it as a type. The fragments from St. 272 are unidentifiable, but probably are not *A. bellidifera*; more likely they are *A. ovata*, the Indo-Pacific species.

Family 3. PALAEOPNEUSTIDAE, A. Agassiz.

Peristome more or less transversely elongated, with the primordial plate of interambulacrum V modified to form a more or less well-marked labrum; ambulacra flush, not petaloid or imperfectly so; fascioles generally wanting, but subanal (and in a few species, peripetalous) may be present.

This rather ill-defined family of a dozen genera and more than two dozen species is represented in the Museum by 7 species of 6 genera. All the material is from either the *Challenger* or the *Blake* collections.

1. GENICOPATAGUS.

A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 210.

Type, *Genicopatagus affinis* A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 210.

No fascioles; periproct distinctly on dorsal surface.

1. *Genicopatagus affinis*.

A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 210. 1881, *Challenger* Ech., pl. XXXI, figs. 12-22.

Actinal surface flat; mouth only slightly anterior; ambulacra similar.

5 specimens from *Challenger* St. 157, south-eastern Indian Ocean, 1,950 fms., diatom ooze.

One of these specimens is broken, but another is very fine. One bears the label '*Challenger* St. 60', a station north-east of Bermuda, in 2,575 fms., at which the trawl failed to reach the bottom. Obviously this label is misplaced.

2. ARCHAEOPNEUSTES.

Gregory, 1892. Quart. Jour. Geol. Soc. London, 48, p. 163.

Type, *Palaeopneustes hystrix* A. Agassiz, 1880. Bull. M.C.Z., 8, p. 82.

Ambulacra more or less petaloid, with interporiferous areas well developed; labrum and phyllodes well developed; periproct on oral surface; actinal ambulacra coarsely tuberculated like the interambulacra.

1. *Archaeopneustes hystrix*.

Palaeopneustes hystrix A. Agassiz, 1880. Bull. M.C.Z., 8, p. 82. 1883, Mem. M.C.Z., 10, No. 1, pl. XVIII and pl. XIX, fig. 2.

Test moderately high; mouth distinctly anterior; length of test more than twice its height.

1 specimen from *Blake* St. 166, off Guadeloupe, 150 fms.

This is a fine typical example.

3. PALAEOPNEUSTES.

A. Agassiz, 1873. Bull. M.C.Z., 3, p. 188.

Type, *Palaeopneustes cristatus* A. Agassiz, 1873. Bull. M.C.Z., 3, p. 188.

Similar to *Archacopneustes*, but test is higher, mouth is more anterior, and actinal ambulacra are more or less bare, with no large tubercles.

1. *Palaeopneustes cristatus*.

A. Agassiz, 1873. Bull. M.C.Z., 3, p. 188. 1874, Ill. Cat. M.C.Z., 8 (1), pl. IV, figs. 1-3.

Primary spines numerous, rather small, not conspicuously larger than secondaries; ambulacrum III not at all sunken; labrum scarcely twice as long as wide; colour dark violet.

2 specimens, from *Blake St.* 156, off Montserrat, 88 fms., and from *Blake St.* 202, off Martinique, 210 fms.

These are fine examples of one of the most characteristic West Indian Spatangoids.

4. ARGOPATAGUS.

A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 209.

Type, *Argopatagus vitreus* A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 209.

Subanal fasciole present, more than twice as wide as long; no peripetalous fasciole: no large primaries with deeply sunken scrobicules.

1. *Argopatagus vitreus*.

A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 209. 1881, *Challenger* Ech., pl. XXXII, figs. 1-6.

Test very fragile, low, highest at or just behind the middle.

1 specimen and fragments of another from *Challenger St.* 191, Arafura Sea, 800 fms., mud.

This is the type.

5. PALAEOTROPUS.

Lovén, 1872. Öfv. Vet.-Akad. Förh. f. 1871, no. 8, p. 21.

Type, *Palaeotropus josephinae* Lovén, 1872. Öfv. Vet.-Akad. Förh. f. 1871, no. 8, p. 21.

Subanal fasciole present (wanting in adults of *P. josephinae*); ambulacra not at all petaloid, except in adult *P. josephinae*; test fragile.

1. *Palaeotropus loveni*.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 204. 1881, *Challenger* Ech., pl. XXI, figs. 3-16.

Test highest posteriorly, distinctly narrower in front than behind; genital pores 3.

22 specimens, mostly bare, and many fragments from *Challenger* St. 210, Philippine Islands, 375 fms., mud.

This is type material from the only station where the genus was found.

6. HOMOLAMPAS.

A. Agassiz, 1872. Rev. Ech., pt. 1, p. 137.

Type, *Lissonotus fragilis* A. Agassiz, 1869. Bull. M.C.Z., **1**, p. 273.

Subanal fasciole present; some large primaries in dorsal interambulacra with deeply sunken scrobicules.

1. *Homolampas fragilis*.

Lissonotus fragilis A. Agassiz, 1869. Bull. M.C.Z., **1**, p. 273.

Homolampas fragilis A. Agassiz, 1872. Rev. Ech., pt. 1, p. 137, pl. XVII, figs. 13-21.

No anal rostrum; peristome and ambulacrum III in front of it not deeply sunken; peripetalous fasciole indistinct or wanting.

Fragments only from *Challenger* St. 122, off northern Brazil, 350-400 fms., mud.

These fragments are almost unidentifiable, but, because of the locality, Agassiz assigned them to this species.

2. *Homolampas fulva*.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 209. 1881, *Challenger* Ech., pl. XXIV.

Peristome and ambulacrum in front of it deeply sunken; no anal rostrum; test very wide.

1 specimen and fragments of another, or perhaps 2, from *Challenger* St. 271, Central Pacific, 2,425 fms., globigerina ooze.

This is a superb specimen, and may fairly be considered the holotype of the species, as it appears to be the only whole specimen collected, and is obviously the one from which the figures were made. The specimen in the Museum of Comparative Zoölogy from *Challenger* St. 271 is fragmentary.

Family 4. HEMIASTERIDAE, H. L. Clark.

Some or all of the ambulacra more or less sunken, or more or less petaloid, or both; subanal fasciole wanting.

This family is well represented in the Museum by more than 300 specimens of more than half the known species. The

family is particularly characteristic of the Antarctic and sub-Antarctic seas, and the various recent Antarctic expeditions have brought back much valuable material. Owing to sex differences in some genera and our imperfect knowledge of growth changes in most species, the identification of this material has involved considerable difficulty. Of several genera and many species, material is still much too scanty to make the present distinctions thoroughly reliable.

1. AMPHIPNEUSTES.

Koehler, 1900. Bull. Acad. Belgique (3), **38**, p. 817.

Type, *Amphipneustes lorioli* Koehler, 1900. Bull. Acad. Belgique (3), **38**, p. 817.

No fascioles ; test moderately high ; petals more or less sunken.

1. *Amphipneustes koehleri*.

Mortensen, 1905. Vid. Medd., p. 243. 1910, Swedish South Polar

Exp. Ech., pl. XI, figs. 2-5, 7, 8, 15, 18, pl. XII, figs. 1, 3, 5, 7.

Periproct on posterior vertical end of test, not visible from below.

8 specimens from South Georgia, off Larsen Point ; labelled *Abatus shackletoni*.

This is a very good series ranging from 10 to 28 mm. in length, and therefore still young. The colour is brown.

2. *Amphipneustes lorioli*.

Koehler, 1900. Bull. Acad. Belgique (3), **38**, p. 817. Mortensen,

1910. Swedish South Polar Exp. Ech., pl. XI, figs. 17 and 19.

Periproct on oral surface ; test high ; petals nearly or quite flush with test.

3 specimens, 2 from off Cape Adare, 20-24 fms. (*Southern Cross*), and 1 from the *Terra Nova* collection.

These are small, much smaller than those previously known ; hence their identification is not perfectly satisfactory. The *Terra Nova* specimen is the smallest, measuring $29 \times 25 \times 17$ mm. : the colour is light brown and there are no genital pores ; globiferous pedicellariae are rather numerous and are very conspicuous because of their dark brown glandular skin. The Cape Adare specimens are very low, the height not quite half the length ; they measure $32 \times 27 \times 15$ mm. and $41 \times 35 \times 18$ mm. : the colour is deep purple ; hence the pedicellariae are not conspicuous.

2. AGASSIZIA.

Valenciennes, 1846. Voy. *Vénus* : Zooph., pl. I, figs. 2-2 f.

Type, *Agassizia scrobiculata* Valenciennes, 1846. Voy. *Vénus* : Zooph., pl. I, figs. 2-2 f.

Peripetalous fasciole present ; ambulacra II and IV dorsally not petaloid and not sunken, the anterior series of pore-pairs wanting.

1. *Agassizia excentrica*.

A. Agassiz, 1869. Bull. M.C.Z., 1, p. 276. 1872, Rev. Ech., pt. 1, pl. XI f, figs. 23 and 24.

Posterior petals little developed, flush with test.

2 specimens, bare, from West Indies, 229 fms., and from Blake St. 247, off Grenada, 170 fms. The specimen from 229 fms. was labelled *Neolampas rostellata*.

2. *Agassizia scrobiculata*.

Valenciennes, 1846. Voy. *Vénus* : Zooph., pl. I, figs. 2-2 f.

Posterior petals well developed, more or less depressed.

7 specimens, of which 3 are bare and 1 has no locality label. Of the others 2 are from Mexico, Mazatlan, and 4 are labelled 'Gulf of Mexico', an obvious blunder.

This is a very good series of this west coast species. The specimens show some diversity in proportions ; the largest one is $42 \times 40 \times 28$ mm., its breadth being 0.95 of the length and its height 0.66. A smaller specimen $34 \times 30 \times 24$ mm. has the width 0.88 of length, but the height just over 0.70.

3. PERICOSMUS.

Agassiz and Desor, 1847. Ann. Sci. Nat. (3), 8, p. 19.

Type, *Micraster edwardsii* Agassiz, 1840. Cat. Sys. Zool., Ect. 2 (*nomen nudum*) - *Schizaster agassizii* Sismonda, 1841. Mon. Ech. Foss. Piémonte, p. 23.

Both peripetalous and marginal fascioles, entirely separated from each other, are present.

1. *Pericosmus abatoides* sp. nov. PLATE XI, figs. 4-6.

Test rather low and wide, 40 mm. long, 35 mm. wide, and 20 mm. high ; the greatest height is just posterior to abactinal system and slightly anterior to middle. Ambulacrum III is not at all sunken at ambitus, so the anterior margin of test is evenly rounded. Genital pores 3, well marked. Abactinal system a little anterior to middle. Petals I and V about 16 mm. long by 4.5 wide, very slightly sunken ; petals II and IV a little shorter and narrower ; ambulacrum III scarcely petaloid, though it is a trifle depressed proximally. Peripetalous fasciole well marked, though narrow posteriorly and laterally ; anteriorly it fades away entirely, but near tip of petal II it is double ; this doubling was not clear at tip of petal IV. Marginal fasciole narrow but very distinct, especially anteriorly. Peristome not deeply sunken, only

a little anterior to middle. No enlarged pedicels near subanal plastron. Pedicellariae not common, but both tridentate and globiferous were found; the latter have the valves 2-toothed, and resemble closely those of *Abatus cavernosus*; the tridentate are small and closely resemble those of *Amphipneustes lorioli*. Colour brown, rather bright, with a yellowish, rather than a reddish or violet, tinge.

East End of Barrier, 100 fms. (*Discovery*). One specimen, a male. Labelled *Hemiaster cavernosus*.

This specimen is the one figured and has been selected as the holotype, but there is a second, and this fortunately is a female. It was taken by the *Terra Nova* at St. 339 (Ross Sea, 140 fms.) and is labelled *Pseudabatus nimrodi*. It is almost exactly like the male in size, proportions and colour, but is conspicuously different in the much larger genital pores and in the character of the petals (excepting ambulaeum III, which is as in the male). Petals I, II, IV and V are very deeply sunken and some or all contain (or have contained) young; the specimen is accompanied by a large number of very small young ones.

This is a very interesting *Abatus*-like sea-urchin and its generic position is dubious. It fits into the genus *Pericormus* without difficulty, but that it is congeneric both with the fossil species and with the recent species from the Indian Ocean is improbable. Unfortunately the material available to Koehler in his study of the Indian form was lacking in spines and pedicellariae, so that it is hard to say how close that species is to this one, but the position of the mouth and the appearance of the ventral surface make me doubtful about the relationship. Until adequate material is available this Antarctic species may conveniently be termed a *Pericormus*.

4. HEMIASTER.

Agassiz and Desor, 1847. *Ann. Sci. Nat.* (3), 8, p. 16.

Type, *Spatangus bufo* Brongniart, 1822. Cuvier's *Oss. Foss.*, 2, pp. 320, 604.

No marginal fasciole, but peripetalous present; abactinal system ethmophract; genital pores 4; no lateroanal fasciole.

1. *Hemiaster expergitus*.

Löven, 1871. *Öfv. Vet.-Akad. Förh.*, no. 8, p. 6, fig. (*desc. impar.*).

Mortensen, 1907. *Ingolf* Ech., pt. 2, pl. 11, figs. 1, 4, 18 and 20.

Petaloid area small; sternum short and wide; test high; peristome anterior.

11 specimens and fragments of 2 others. Localities represented are: Irish Fisheries Board St. S.R. 752, south-west

of Ireland, 523-595 fms., ooze; *Challenger* Stations, VIII, Canary Islands, off Gomera, 620 fms., sandy mud and shells; 126, off the coast of Brazil, 750 fms., mud; 188, Arafura Sea, 28 fms., mud, and 232, off Japan, 345 fms., sandy mud. The fragments from St. VIII and St. 126 were labelled *H. zonatus*, the specimen from St. 188 was labelled *Periaster limicola*, and those from St. 232, *H. gibbosus*.

This material may be referred to *H. expergitus*—a species known to occur in the Western Pacific as well as in the Atlantic; nevertheless, the fragments from Sts. VIII and 126 are unidentifiable. Mortensen, who has examined the Museum material, is very sure that the fragments from St. 126 are not *Hemiaster* at all; probably he is right. I also agree with him in assigning the rest of the specimens to *H. expergitus*. Probably the specimen from St. 188 was not seen by Mortensen.

5. PROTENASTER.

Pomel, 1883. *Class. Meth. Ech.*, p. 36.

Type, *Desoria australis* Gray, 1851. *Ann. Mag. Nat. Hist.* (2), 7, p. 132.

Genital pores 4; lateroanal fasciole present; apex sub-central or anterior; petal III narrow, not petaloid and not sunken.

1. *Protenaster australis*.

Desoria australis Gray, 1851. *Ann. Mag. Nat. Hist.* (2), 7, p. 132.

Protenaster australis Pomel, 1883. *Class. Meth. Ech.*, p. 36.

A. Agassiz, 1873. *Rev. Ech.*, pt. 3, pl. XIX a, figs. 7-9 (as *Linthia australis*).

Apex anterior; periproct not visible from oral side.

17 specimens, of which 16 are bare. All are labelled Tasmania (or Van Diemen's Land) except 2, one of which is said to be from 'Luzon' and one from Philippine Islands, Island of Masbate, 5-20 fms., sandy mud (*Cuming*).

That this species occurs in the Philippine Islands is improbable, as it is not otherwise known from north of New South Wales. Specimens with spines are very rare, but the specimen said to be from Masbate is in that condition. It is small, only 29 mm. long, 24 wide, and 19 high. It seems to be a *Protenaster*, but until specimens from Australia with spines, and of similar size, are available for comparison, it will be impossible to say whether it is *P. australis* or not. Gray's type specimens from Flinders Island do not seem to be in the collection, but it is possible that the largest specimen, which is from 'Van Diemen's Land' and measures $76 \times 64 \times 44$ mm., may be a type of his Var. 1. The specimen supposed to be from Luzon was in a box with a specimen of *Metalia dicrana*, with the label *Brissus areolatus*, and it is probable that

both the locality and the name were intended only for the *Metalia*, the *Protenaster* having been put into the box by mistake.

2. *Protenaster rostrata*.

Linthia rostrata Smith, 1878. Ann. Mag. Nat. Hist. (5), 1, p. 67, figs. a-d.

Protenaster rostrata H. L. Clark, 1917. Mem. M.C.Z., 46, p. 170.

Apex subcentral; periproct overhung by posterior end of test and plainly visible from below.

1 specimen, bare, from an unknown locality, supposed to be in the islands of the Pacific.

This is Smith's holotype, and he has given a very careful account of it. The species seems very distinct and it would be interesting to know its home.

6. PARASTER.

Pomel, 1869. Revue Ech., p. xiv.

Type. *Schizaster gibberulus* Agassiz and Desor, 1847. Ann. Sci. Nat. (3), 8, p. 22.

Apex subcentral or posterior; ambulacrum III more or less petaloid, wide and deeply sunken; genital pores 4.

1. *Paraster gibberulus*.

Schizaster gibberulus Agassiz and Desor, 1847. Ann. Sci. Nat. (3), 8, p. 22.

Paraster gibberulus Pomel, 1869. Revue Ech., p. xiv. Koehler, 1914. Indian Mus. Ech., Spat., pl. VIII, figs. 10 and 11, pl. IX, figs. 1, 2, and 16.

Test high, vertical diameter posteriorly 0.70 length or more; anterior end much lower; ambulacrum III deeply sunken at ambitus.

1 specimen from British East Africa, Wasin, 7 fms. (*Crossland*).

This is young and nearly bare; it measures $20 \times 17 \times 14$ mm.

2. *Paraster savignyi*.

Schizaster savignyi Fourtan, 1904. Bull. Inst. Égypt (4), 4, p. 436.

Paraster savignyi Koehler, 1914. Indian Mus. Ech., Spat., p. 172, pl. VIII, figs. 4, 6, 12-15, pl. IX, figs. 3 and 11.

Test lower than in *S. gibberulus*, and sloping forward less markedly.

8 specimens, of which 1 small bare specimen, labelled *S. gibberulus*, is from the Red Sea, and 7 are from *Challenger* St. 188, Arafura Sea, west end of Torres Strait, 28 fms., mud.

The specimens from St. 188 were named *Schizaster japonicus* (= *S. lacunosus* L.) by Agassiz; they certainly resemble that Spatangoid very closely, but after comparing them with

young *P. lacunosus*, I prefer to regard them as *P. savignyi*. With the exception of the smallest specimen (which measures $14 \times 13 \times 9.5$ mm.), they have 4 genital pores, though pores 2 and 3 are always much smaller than 1 and 4; in the smallest individual pores 2 and 4 are wanting. In *P. lacunosus*, under 15 mm. in length, there are no genital pores in the specimens I have examined. Compared with *P. lacunosus* one notes some minor differences in the test by which specimens lacking 4 genital pores might be distinguished from the *Schizaster*. The labrum is longer in *P. savignyi* and the sides are parallel; a second difference is seen in the sternum, which is much wider anteriorly in proportion to its length in *P. savignyi* than in *S. lacunosus*. The differences between *P. savignyi* and *P. gibberulus* are very slight and it is doubtful if the two species can be maintained.

One of the specimens from St. 188 is 53 mm. long, 46 mm. wide, and 35 mm. high; the lateroanal fasciole is wanting except for a small piece below the periproct; possibly this specimen is of a different species from the others. Possibly this is one of the two specimens that Mortensen (1907. *Ingolf* Ech., pt. 2, p. 108) was inclined to refer to *Schizaster jukesii*.

7. FAORINA.

Gray, 1851. Ann. Mag. Nat. Hist. (2), 7, p. 132.

Type, *Faorina chinensis* Gray, 1851. Ann. Mag. Nat. Hist. (2), 7, p. 132.

Genital pores 3; peripetalous fasciole double, or even triple, anteriorly; test high.

1. *Faorina chinensis*.

Gray, 1851. Ann. Mag. Nat. Hist. (2), 7, p. 132. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XIX a, figs. 4-6.

Test nearly globular, the height about $\frac{3}{4}$ of length, which is little more than width; ambulacra only slightly sunken.

6 specimens, all bare, 2 without locality labels, 2 from 'China Seas', 1 from South China, and 1 from Hong Kong.

The specimens labelled 'China Seas' are very fine, about 55 mm. long, 53 wide, and 40 high, but the individual from South China is notable for its size, $78 \times 73 \times 59$ mm.; this is, I believe, much the largest example of this species on record.

8. TRIPYLUS.

Philippi, 1845. Arch. f. Naturg., 11 (1), p. 344.

Type, *Schizaster (Tripylus) excavatus* Philippi, 1845. Arch. f. Naturg., 11 (1), p. 344.

Ambulacrum III more or less markedly different from the

others: petals more or less sunken; lateroanal fasciole very distinct: petals II and IV do not reach the peripetalous fasciole.

1. *Tripylus excavatus*.

Schizaster (Tripylus) excavatus Philippi, 1845. Arch. f. Naturg., **11** (1), p. 344.

Tripylus excavatus Troschel, 1851. Arch. f. Naturg., **17** (1), p. 67.
Mortensen, 1910. Swedish South Polar Exp. Ech., pl. X1,
figs. 1, 14, and 16.

Colour of test light brown or violet, with the fascioles well marked in deep violet or brownish purple.

2 specimens, 1 labelled South America and the other Straits of Magellan.

This seems to be a rare species, scantily represented in museums, and with a limited geographical range.

9. ABATUS.

Troschel, 1851. Arch. f. Naturg., **17** (1), p. 72.

Type, *Schizaster (Tripylus) cavernosus* Philippi, 1845. Arch. f. Naturg., **11** (1), p. 345.

Lateroanal fasciole partial, indistinct, or wanting; petals II and IV reach, and end at, peripetalous fasciole. Ambulacrum III more or less different from the other ambulacra, which are petaloid and more or less sunken.

1. *Abatus agassizii*.

Mortensen, 1910. Swedish South Polar Exp. Ech., p. 86, pl. X,
figs. 5, 9, 14.

Tube-feet near periproct not enlarged; ambulacrum III not sunken; apical system central; peripetalous fasciole not near margin.

3 specimens, 1 from *Challenger* St. 151, off Heard Island, 75 fms., mud, and 2 from *Terra Nova* St. 355, Ross Sea, 300 fms. The *Challenger* specimen was labelled *Hemiaster cavernosus* and the *Terra Nova* specimens were named *Pseudabatus nimrodi* by Bell.

The *Challenger* specimen is only 20 mm. long and is thus too young for positive identification in this difficult genus. The *Terra Nova* specimens are puzzling, but I feel very sure they are not *A. nimrodi*; they are very dark brown, almost blackish. The larger is $60 \times 55 \times 37$ mm.; in this specimen the peripetalous fasciole is present only in part, notably at and anterior to the tips of petals II and IV, where it is perfectly clear.

2. Abatus cavernosus.

Schizaster (Tripylus) cavernosus Philippi, 1845. Arch. f. Naturg., **11** (1), p. 345.

Tripylus (Abatus) cavernosus Troschel, 1851. Arch. f. Naturg., **17** (1), p. 72.

Abatus cavernosus Lovén, 1883. Svensk. Vet.-Akad. Handl., **19**, No. 7, p. 25. Mortensen, 1910. Swedish South Polar Exp. Ech., pl. IX, pl. X, figs. 2, 4, 6-8, 10-13.

3-6 pairs of tube-feet near periproct enlarged; petals II and IV diverging from long axis of test at an acute angle; petals I and V as wide as II and IV; in female all 4 are deeply sunken.

7 specimens, of which 1 is without locality. Localities represented are: South Polar seas; South America; Falkland Islands.

The Falkland Islands specimen is small and bare, and all the others are more or less damaged.

3. Abatus cordatus.

Hemiaster cordatus Verrill, 1876. Bull. U.S. Nat. Mus., **3**, p. 69.

Abatus cordatus Studer, 1876. Monatsb. Berlin Akad. Wiss., p. 457. Mortensen, 1909. Deutsch. Südpolar-Exp. Ech., pl. XVIII, figs. 2, 4, 16, 20.

Petals about equal, but II and IV diverge from long axis of test at a wide angle; ambulacrum III deeply sunken dorsally, and anterior margin of test correspondingly notched.

27 specimens from Kerguelen, from the *Challenger* collection. Most of the material was labelled *Hemiaster cavernosus*, but some were named *H. philippii*. Localities given are: Kerguelen, 250 fms.; Royal Sound; Betsy Cove, 15-20 fms.

Many of the specimens are young, but this series is on the whole a satisfactory representation of this species, which seems to be confined to Kerguelen.

4. Abatus koehleri.

Hemiaster elongatus Koehler, 1907. Zool. Anz., **32**, p. 147 (*pre-occupied*). 1908, Trans. Roy. Soc. Edinburgh, **46**, pl. XVI, figs. 145-158.

Hemiaster koehleri Thiéry, 1909. Rev. Crit. Pal., **13**, p. 187.

Abatus koehleri H. L. Clark, 1917. Mem. M.C.Z., **46**, p. 177.

Modified or sunken portion of paired petals begins close to abactinal system; test narrow, its width only about 0.80 of its length.

2 specimens from the South Orkneys, Scotia Bay, 6-10 fms., labelled *Hemiaster elongatus*.

These are superb specimens, evidently cotypes; one is 43 × 34.5 mm., the other is 26 × 21 mm.

5. *Abatus nimrodi*.

Pseudabatus nimrodi Kochler, 1911. Brit. Antaret. Exp., Biol., 2, pt. 4, p. 60, pl. VII, figs. 1-8, and pl. VIII, figs. 7-12.

Abatus nimrodi H. L. Clark, 1917. Mem. M.C.Z., 46, p. 177.

Modified or sunken portion of paired petals begins only some 8 or 9 pore-pairs distant from abactinal system.

2 specimens from *Terra Nova* St. 294, Ross Sea, 158 fms.

6. *Abatus shackletoni*.

Kochler, 1911. Brit. Antaret. Exp., Biol., 2, pt. 4, p. 51, pl. IV, figs. 3-10, and pl. VIII, figs. 1-6.

Ambulacrum III not sunken; apical system anterior; peripetalous fasciole, especially anteriorly, nearly or quite reaches ambitus.

51 specimens, of which 45 are from Cape Adare, 20-24 fms. (*Southern Cross*); of the rest, 3 are from Winter Quarters, 20 fms. (*Discovery*), 2 are from west of Coulman Island, 100 fms. (*Discovery*), and 1 is from Ross Sea, 140 fms., *Terra Nova* St. 339. The *Southern Cross* and *Discovery* specimens were labelled *Hemiaster cavernosus*.

The Cape Adare specimens range in length from 12 to 59 mm.; the largest is 53 mm. wide but only 27 mm. high; they are mostly males; one, 42 mm. long, has 4 normal genital pores; the peripetalous fasciole is often very indistinct and even wanting anteriorly. Two specimens are noticeably different from the others: one of these is 39 × 35 × 19 mm., dark brown in colour, but spotted with black; the other, a trifle smaller, has the test very light brown, although the spines are dark brown. The *Terra Nova* specimen is very light coloured. Most of the young specimens from Cape Adare are yellow-brown: one of them is remarkable in that the lateroanal fasciole is complete, as in *Tripylus*. Among the *Discovery* material is a fragment, the anterior end of a test, which is 60 mm. wide, indicating a specimen about 67 mm. long.

10. BRISASTER.

Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 61.

Type, *Brissus fragilis* Düben and Koren, 1846. Arch. Skand., 1, p. 439.

Test low, apex posterior; genital pores 3; posterior petals relatively short; petals II and IV at first little divergent, then becoming more so, and at tip markedly curved outward.

1. *Brisaster fragilis*.

Brissus fragilis Düben and Koren, 1846. Arch. Skand., 1, p. 439.

Schizaster (Brisaster) fragilis Gray, 1855. Cat. Rec. Ech. Brit.

Mus., p. 61. Mortensen, 1907. Ingolf Ech., pt. 2, pl. 1, figs. 6 and 7.

Lateroanal fasciole complete (rarely interrupted); ambulacral III moderately wide; width of anterior end of petal III about one-third its length; other petals narrow and not truncate.

63 specimens from the following localities: Greenland, 410 fms.; north-eastern America; Gulf of St. Lawrence, 200 fms.; off Martha's Vineyard, 250 fms.; off Delaware Bay, 197 fms.; Varanger Fjord, 125–154 fms.; Finmark; Norway; Trondhjem Fjord, 150–300 fms.; Cape of Good Hope; *Challenger* St. 142, Cape of Good Hope, 150 fms., sand. One of the Cape of Good Hope specimens was labelled *Echinocardium*.

There are some very fine specimens from Norway, the American coast, and the Cape; the absence of this species from the eastern Atlantic Ocean makes its distribution quite extraordinary, although several other European Echinoderms are found at the Cape. An example from the Varanger Fjord is 67 mm. long by 60 mm. wide.

2. *Brisaster kerguelensis*.

H. L. Clark, 1917. Mem. M.C.Z., 46, p. 184, pl. CLIV, figs. 15–17.

Lateroanal fasciole reduced or wanting; petals I and V usually about one-third of II and IV; vertical diameter often less than one-half length; sternum nearly 3 times as long as wide.

7 specimens from Kerguelen, *Challenger* St. 149 g, off London River, 110 fms.; labelled *Schizaster philippii*, but published in *Challenger* Report as *S. moseleyi*.

The largest perfect specimen is $59 \times 52 \times 31$ mm., but the fragment of an anterior half, which is 58 mm. across, indicates a specimen 65–66 mm. long.

3. *Brisaster latifrons*.

Schizaster latifrons A. Agassiz, 1898. Bull. M.C.Z., 32, p. 81.

Schizaster (Brisaster) latifrons Mortensen, 1907. *Ingolf* Ech., pt. 2, p. 123. A. Agassiz, 1881. *Challenger* Ech., pl. XXXVI, figs. 1–3 (as *Schizaster ventricosus*).

Lateroanal fasciole reduced or wanting; sternum not twice as long as wide; petal III very wide, one-third to one-half its own length; vertical diameter about half length or less.

10 specimens, of which 1 is bare, from Korean coast; Japan, *Challenger* St. 232, 345 fms., sandy mud; Sagami Sea, $35^{\circ} 10' N.$, $139^{\circ} 44' E.$ The Sagami Sea specimens were labelled *Schizaster japonicus*, and the others *S. ventricosus*.

The Sagami Sea specimens are unusually dark brown, but are not otherwise notable.

4. *Brisaster moseleyi*.

Schizaster moseleyi A. Agassiz, 1881. *Challenger* Ech., p. 203, pl. XXXVI, figs. 14-16.

Schizaster (Brisaster) moseleyi Mortensen, 1907. *Ingolf* Ech., pt. 2, p. 123.

Lateroanal fasciole reduced: test high, vertical diameter often much more than half horizontal: petal III narrow, its width about one-fourth its length.

30 specimens from the *Challenger* collection, from the west coast of Chile: St. 305, 120 fms., mud; St. 309, 40-140 fms., mud; St. 310, 400 fms., mud; St. 311, 245 fms., mud. A specimen labelled '*Schizaster philippii*. Tongatabu' illustrates the danger of a misplaced label; it is doubtless from Chile. The specimen listed in the *Challenger* Report as from St. 146 is crushed and hopelessly unidentifiable, but it is safe to say it is not *B. moseleyi*. Nearly all the specimens were labelled *Schizaster philippii*, though published in the *Challenger* Report as *S. moseleyi*.

This is a good series of young and adult specimens of this characteristic Chilean species. The best are those from St. 311: these measure from $38 \times 35 \times 21$ mm. to $56 \times 52 \times 32$ mm.: they are a fine red-brown with a distinctly purple cast.

11. *HYPSELASTER*.

H. L. Clark, 1917. Mem. M.C.Z., 46, p. 185.

Type, *Schizaster (Periaster) limicola* A. Agassiz, 1878. Bull. M.C.Z., 5, p. 193.

Test high; only 2 genital pores; lateroanal fasciole incomplete or wanting; petals more or less sunken.

1. *Hypselaster fragilis*. PLATE XI, figs. 1-3.

Periaster fragilis A. Agassiz and Clark, 1907. Bull. M.C.Z., 51, p. 138.

Hypselaster fragilis H. L. Clark, 1917. Mem. M.C.Z., 46, p. 189.

Test highest posteriorly: apical system a little excentric anteriorly; petaloid area small: petals rather considerably sunken.

2 specimens from *Challenger* St. 188, western end of Torres Strait (Arafura Sea), 28 fms., mud, labelled *Periaster limicola*, and from Cape York (*Jukes*).

As *H. fragilis* was described from a very immature specimen, it is with some hesitation that I assign these individuals to that species. The *Challenger* specimen (the one figured) is 40 mm. long by 36 mm. wide; anteriorly it is 23 mm. high but posteriorly it is 27. Ambulacrum III is quite deeply depressed dorsally, but not at all at ambitus. The abactinal system is a trifle anterior to centre. There are only faint traces of a fasciole below the periproct. The colour is nearly

white, but the specimen is probably more or less bleached. On the whole it seems to me quite probable that this is the adult of *H. fragilis*, even though the type of that species was taken at a much greater depth. This is one of the two specimens that Mortensen (1907, *Ingolf* Ech., pt. 2, p. 108) was inclined to identify as *Schizaster jukesii*.

The Cape York specimen is much larger, 60 mm. long by 52 mm. wide; the posterior end is 42 mm. high, but the anterior is only 30 mm. The abaectinal system is central. Ambulacrum III is deeply depressed (6 mm. or more) on the dorsal surface and about 2 mm. at ambitus, very much as in *Brisaster*. There is no fasciole below periproct. Colour nearly white, but no doubt more or less bleached. The specimen came into the collection in 1846. The differences between this individual and that from St. 188 may easily be explained as growth changes, but I doubt whether they are specifically identical.

12. OVA.

Gray, 1825. *Ann. Phil.*, 26, p. 431.

Type, *Spatangus canaliferus* Lamarek, 1816. *Anim. s. Vert.*, 3, p. 31.

Lateroanal fasciole complete, distinct; genital pores 2; petals, especially III, sunken; ambulacral pores in III in a double series.

1. Ova canalifera.

Spatangus canaliferus Lamarek, 1816. *Anim. s. Vert.*, 3, p. 31.

Ova canalifera Gray, 1825. *Ann. Phil.*, 26, p. 431. A. Agassiz, 1873. *Rev. Ech.*, pt. 3, pls. XXIII a, figs. 1-3, pl. XXXIII, fig. 7 (as *Schizaster canaliferus*).

Large; test rather high; ambulacrum III deeply sunken anteriorly as well as abaectinally; posterior petals small.

12 specimens, of which 1 is without locality. Localities represented are: Mediterranean; Sicily; Naples; Cape of Good Hope, near Bird Island, 29 fms. The Cape specimens are labelled *Schizaster fragilis*.

The specimens from the Mediterranean region are all small and afford no comparison with the huge ones from the Cape. Of these, one is $90 \times 74 \times 55$ mm. and the other is $100 \times 79 \times 61$ mm. Mortensen has examined them and considers (1907, *Ingolf* Ech., pt. 2, p. 116) them a species distinct from *S. canaliferus*, but until they can be compared with specimens of at least fully adult size from the Mediterranean they do not require a new name. Mortensen refers to them as 'almost naked', but the larger is well covered with spines; both are badly discoloured by iron rust.

13. SCHIZASTER.

Agassiz, 1836. Mém. Soc. Sci. Nat. Neuchâtel, 1, p. 185.

Type, *Schizaster studeri* Agassiz, 1836. Mém. Soc. Sci. Nat. Neuchâtel, 1, p. 185.

Similar to *Ora*, but ambulacral pores in petal III in a single series on each side.

1. *Schizaster edwardsi*.

Cotteau, 1889. Bull. Soc. Zool. France, 14, p. 341. Comptendu Congrès Internat. Zool., pl. III, figs. 7-12.

Petal III very wide; posterior petals oval, the width half the length or more, strongly divergent.

4 specimens, bare tests, from Lagos, labelled *S. canaliferus*.

These are very fine specimens, $44 \times 39 \times 32$ mm. to $52 \times 47 \times 37$ mm., and seem to confirm the validity of the species. Compared with *S. lacunosus* of the same size, it may be noted that the colour is grey, not brown or brownish. More important are the differences in the petals; in *S. edwardsi* the unpaired petal (III) is 9-10 mm. wide, but in *S. lacunosus* it is only 7-8 mm. In *S. edwardsi* petals I and V are 9-10 mm. long by 5 mm. wide, oval in form, but in *S. lacunosus* they are 9 mm. long $\times$ 3.5 mm. wide, long elliptical in form.

2. *Schizaster lacunosus*.

Echinus lacunosus Linné, 1758. Sys. Nat., ed. 10, p. 665.

Schizaster lacunosus Lovén, 1887. Bih. Svensk. Vet.-Akad. Handl., 13 (4), No. 5, p. 168. A. Agassiz, 1881. Challenger Ech., pl. XXXVI, figs. 8-13 (as *S. japonicus*).

Ambulacrum III wide, but narrower than in *S. edwardsi*; posterior petals longer and less divergent; sternum broad, its posterior width about two-thirds of its length.

10 specimens, of which 2 are bare and 2 have no locality labels. Localities represented are: Maldive Islands, Mulaku (*Gardiner*); China, Chusan Archipelago; Japan; Kobe; off Yokohama, Challenger St. 233 b, 15 fms., mud. The specimen from China was labelled *Echinocardium*; most of the others were named *S. japonicus*.

This is a fairly good series, the 2 specimens from Kobe being fine; the larger measures $48 \times 42 \times 34$ mm.

14. MOIROPSIS.

A. Agassiz, 1881. Challenger Ech., p. 205.

Type, *Schizaster claudicans* A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 211.

Peripetalous fasciole follows closely the margins of petals II and IV: all petals very deeply sunken; lateroanal fasciole well marked; genital pores 2; petals II and IV longer and wider than III.

1. *Moiropsis claudicans*.

Schizaster claudicans A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 211.

Moiropsis claudicans A. Agassiz, 1881. *Challenger* Ech., p. 205; pl. XXXVI, figs. 4-7.

Test very wide and high, the posterior end of actinal surface projects somewhat, so that the rear end of test is somewhat concave; petaloid area small.

One specimen from *Challenger* St. 192, near the Kei Islands, 129 fms., mud.

This is the unique holotype of this remarkable sea-urchin, and fortunately is in fine condition.

15. MOIRA.

A. Agassiz, 1872. Rev. Ech., pt. 1, p. 146.

Spatangus atropos Lamarck, 1816. Anim. s. Vert., **3**, p. 32.

Peripetalous fasciole follows closely the margins of petals II and IV, which are not longer and wider than III; petals so deeply sunken as to be enterable only through narrow slits.

1. *Moira atropos*.

Spatangus atropos Lamarck, 1816. Anim. s. Vert., **3**, p. 32.

Moira atropos A. Agassiz, 1872. Rev. Ech., pt. 1, p. 146, pl. XXIII.

Interambulacra 2 and 3 within the peripetalous fasciole, considerably and abruptly depressed; posterior end of test nearly or quite vertical; phyllodes small and actinal ambulacra narrow and not very bare.

14 specimens, of which 2 are bare and 3 have no locality labels. Localities represented are: North Carolina, Beaufort; South Carolina, Charleston; Texas; West Indies; St. Thomas.

Most of these specimens are in poor condition, but the one from St. Thomas is fine. The specimen labelled 'West Indies' is remarkably wide and flat, 40 mm. long, by 34 wide, and only 23 mm. high.

2. *Moira stygia*.

Moera stygia A. Agassiz, 1872. Bull. M.C.Z., **3**, p. 58.

Moira stygia A. Agassiz, 1872. Rev. Ech., pt. 1, p. 147. (Never figured.)

Interambulacra 2 and 3 within the peripetalous fasciole only slightly and not abruptly depressed; posterior end of test somewhat concave, its lower margin projecting further aborally than its upper portion.

7 specimens, of which 3 have no locality labels, but were given by J. B. Jukes. Localities represented are: Suez; Red Sea; Andaman Islands. The specimens without locality

and that from the Andaman Islands were labelled *M. atropos*, and the best one from the Red Sea was named *Schizaster gibberulus*.

This is a very rare species. The Andaman Islands specimen is very fine, 34 mm. long on the oral surface and 32.5 mm. abactinally, 26 mm. wide at tips of anterior petals and 20 mm. across tips of posterior pair, and 26 mm. high. The largest specimen is one of those presented by J. B. Jukes; it is 45 (or 43) mm. long, 34 (or 26) mm. wide, and 33.5 mm. high. Probably these Jukes specimens came from the coast of Queensland, for most of his material is from that region. Moreover in 1913 I saw some Moiras, apparently this species, from the Queensland coast, in the Brisbane Museum.

Family 5. SPATANGIDAE, Gray.

Peristome transversely elongated; some or all of the ambulacra more or less petaloid, or more or less sunken, or both; subanal fasciole present.

This large family is well represented by nearly a thousand specimens of more than forty species. Most of these are well known, but one proves to be new to science.

1. **BRISSOPSIS.**¹

Agassiz and Desor, 1847. Ann. Sci. Nat. (3), 8, p. 14.

Type, *Brissus lyrifer* Forbes, 1841. British Starfishes, p. 187.

No internal fasciole, but a well-marked peripetalous fasciole is present, a single band throughout its course; petals well formed; ambulacrum III more or less distinctly sunken and petaloid dorsally; petals I and V often the shortest.

1. **Brissopsis alta.**

Mortensen, 1907. Ingolf Ech., pt. 2, p. 159, pl. III, figs. 5, 8, 9, 13, 16.

Posterior petals divergent; test more or less globular, truncate posteriorly; apical system and peristome anterior.

3 specimens from *Blake* St. 49, Gulf of Mexico, 118 fms., labelled *Periaster limicola*.

These are fine examples of this interesting species, from the station where the *Blake* found it abundant in company with *Hypselaster limicolus*, which it superficially resembles to an extraordinary degree. It is not altogether unlikely that it is a hybrid between *Hypselaster* and *Brissopsis*.

¹ One specimen labelled '*Brissopsis marticensana*, Martiques, Mediterranean' is in fragments and quite unidentifiable.

2. *Brissopsis atlantica*.

Mortensen, 1907. *Ingolf* Ech., pt. 2, p. 160, pl. III, figs. 6, 10, 17.

Posterior petals more or less merged proximally; petaloid area about two-thirds of test length; anterior petals ascending; posterior end of test oblique, so that periproct is more or less dorsal.

1 specimen from *Blake* St. 341, off eastern coast of United States, 1,241 fms., labelled *B. lyrifera*.

This is a good typical example; the validity of this species is none too certain.

3. *Brissopsis luzonica*.

Kleinia luzonica Gray, 1851. *Ann. Mag. Nat. Hist.* (2), 7, p. 133.

Brissopsis luzonica A. Agassiz, 1872. *Rev. Ech.*, pt. 1, p. 95.

H. L. Clark, 1917. *Mem. M.C.Z.*, 46, pl. CLV, figs. 2 and 3.

Posterior petals more or less merged proximally; petaloid area about two-thirds of test length; anterior petals ascending, diverging but little; posterior end of test truncate, so periproct is not visible from above.

29 specimens, chiefly from the following *Challenger* stations: Tahiti Harbour, 20 fms.; St. 168, off eastern New Zealand, 1,100 fms., grey ooze; St. 188, west end of Torres Strait (Arafura Sea), 28 fms., mud; St. 191, near Kei Islands, 800 fms., mud; St. 203, Philippine Islands, 12-20 fms., mud; St. 232, off south-eastern Japan, 345 fms., sandy mud. There are also specimens from Zanzibar, 10 fms. (*Crossland*), and 'Flinders, Clairmont', sand and mud (*Alert*), labelled *Echinocardium australe*.

Some of these are very young and others are fragments; hence the identification is not beyond question. The species has a very fragile test and perfect adult specimens are relatively rare.

4. *Brissopsis lyrifera*.

Brissus lyrifer Forbes, 1841. *Brit. Starfishes*, p. 187.

Brissopsis lyrifera Agassiz and Desor, 1847. *Ann. Sci. Nat.* (3),

8, p. 14. Mortensen, 1907. *Ingolf* Ech., pt. 2, pl. III, figs. 3, 12, 18, 20-23.

Posterior petals divergent; test truncate posteriorly, so that periproct is scarcely visible from above; petals I and V shorter than II and IV; test more or less flattened; abactinal system more or less flattened.

111 specimens, of which 1 is bare and 1 is without locality label. Localities represented are: Norway; Dogger Bank; Scotland, west coast; Upper Loch Torridon, 30-40 fms.; Loch Dulch, 60 fms.; Loch Hourn, 70 fms.; Lower Loch Fyne, 80 fms.; between Great Cumbræ and Wemyss Ground; between Cumbræ and Arran, 90 fms., mud; Kilbrennan Sound, 10-45 fms.; Kilbrennan Sound, west of Brown Point, 10-15 fms.; mouth of Kilbrennan Sound, 22 fms.; between

Sanda Island and Ailsa Crag; Irish Fisheries Board St. S.R. 755, west from Dingle Bay, 92-100 fms., fine sand; Atlantic Ocean; Bay of Biscay, 20-80 fms.; Mediterranean Sea; South Africa, *Challenger* St. 141, 98 fms., sand and gravel; St. 142, 150 fms., sand; Cape of Good Hope; Simon's Bay, 5-18 fms.; 60 miles west of Cape Town, 100 fms.; off Cape Hangklip, 105 fms.; off Struis Point, 42-48 fms. Many from the Cape of Good Hope were labelled *Echinocardium australe*.

This is a very fine series, almost as representative of South Africa as of Scotland. A specimen from Simon's Bay has the anterior petals very divergent, but it is only 15 mm. long, and is too young to be considered anything more than an interesting variant. The specimens from off Struis Point are very fine, the largest measuring $70 \times 60 \times 39$ mm., but one from the west coast of Scotland is $75 \times 62 \times 42$ mm. The specimen from the Mediterranean is labelled '*Metalia* yg.'; it is only $25 \times 19 \times 14$ mm., and perhaps might as correctly be called *B. atlantica*, but it seems more probable that it is *B. lyrifera*.

2. PLAGIOBRISUS.

Pomel, 1883. Class. Meth. Ech., p. 29.

Type, *Spatangus pectoralis* Lamarek, 1816 *Echinus grandis* Gmelin, 1788. Linné's Sys. Nat., ed. 13, 1, pt. 6, p. 3200.

Test wide and low; a distinct anal fasciole present on each side of periproct; big primary tubercles present within peripetalous fasciole in interambulacra 1 and 4, and sometimes in 2, 3, and 5.

1. *Plagiobrissus grandis*.

Echinus grandis Gmelin, 1788. Linné's Sys. Nat., ed. 13, 1, pt. 6, p. 3200.

Plagiobrissus grandis H. L. Clark, 1917. Mem. M.C.Z., 46, p. 207. A. Agassiz, 1872. Rev. Ech., pt. 1, pl. XXI, figs. 4 and 5 (as *Metalia pectoralis*).

Test very large with big primary tubercles in dorsal parts of interambulacra 1, 2, 3, and 4; peristome squarish, rarely more than twice as wide as long.

8 specimens, of which 3 are bare and 1 has no locality label. Localities represented are: West Indies; Bahamas; Nassau; Dominica; Brazil, off Bahia (*Challenger*).

The *Challenger* material consists of two small fragments. The other specimens are typical examples of this handsome and unmistakable *Spatangoid*.

3. METALIA.

Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 51.

Type, *Spatangus sternalis* Lamarek, 1816. Anim. s. Vert., 3, p. 31.

Test big, wide and high ; an anal fasciole present on each side of periproct ; no big primary tubercles within the peripetalous fasciole.

1. *Metalia dicrana*.

H. L. Clark, 1917. Mem. M.C.Z., 46, p. 211, pl. CLX, figs. 1-4.

Apical system anterior ; petals I and V not at all confluent ; vertical diameter more than half test length ; sternum with 2 points, 3-5 mm. apart, where it meets subanal fasciole.

5 specimens, of which 4 are bare and 1 has no locality label. Localities represented are : Luzon ; Samoa ; coast of Savaii. All are labelled *Metalia sternalis*.

This well-marked species was described from 3 specimens in the Museum of Comparative Zoölogy, from the Philippines, the Pelew Islands, and Fiji ; the present material extends the range to Samoa. One of the Samoan specimens is a trifle larger than the largest of the original trio ; it measures $63 \times 57 \times 38$ mm. The specimen from Savaii has the test reddish-orange, although the spines are white, which suggests that the species may be in life more brightly coloured than is usual among Spatangoids.

2. *Metalia latissima* sp. n. PLATES XI, fig. 7 and XII, figs. 1 and 2.

Test very wide and high, 90 mm. long, 86 mm. wide across middle of posterior petals, and 54 mm. high in the posterior third ; at middle the test is a trifle narrower and lower. The width is thus 0.96 of length and the height is 0.60. Apical system about 34 mm. from anterior end, but its component plates are gone. Ambulacrum III narrow, but depressed with adjoining margins of interambulacra, especially at ambitus, so that there is a broad deep notch there. Petals I and V about 40 mm. long by 10 wide, with some 28 pore-pairs, not at all confluent, but even at apical system fully 3 mm. apart. Petals II and IV 35×10 mm., with about 23 pore-pairs, markedly divergent, the angle between them being about 135° - 140° . Interambulacrum 5 not depressed below apical system and interambulacra 1 and 4, but elevated like the adjoining interambulacra, as high 25 mm. behind apical system as they are 10 mm. from it on each side.

Peripetalous fasciole very broad, especially in interambulacrum 5, not very sinuous. Subanal fasciole also broad and distinct. Anal fasciole very distinct though narrow. On each side of subanal plastron are 6 large tube-feet within the fasciole. Subanal plastron 34×25 mm., measured to include fasciole ; 29×22 mm. if measured within fasciole. Periproctal region vertically truncate or slightly inclined outward, so that subanal plastron projects distinctly beyond periproct ; hence

the latter is wholly hidden from below. Periproct 13 mm. high by 8 mm. wide. Peristome 6 mm. long by 13 mm. wide, with the broad labrum projecting very little. Tubercled part of sternum about 50×27 mm. Rear of sternum with a single point as in *M. sternalis*.

Test perfectly bare, without a spine or pedicellaria, of a dirty yellowish colour.

India, Tuticorin. One specimen, labelled *M. sternalis*.

Possibly this is an extreme variant of *M. sternalis*, but the differences in petals, peristome, sternum, and subanal plastron are as great as is the difference in form, and I do not think they can be regarded as merely correlative.

3. *Metalia spatagus*.

Echinus spatagus Linné, 1758. Sys. Nat., ed. 10, p. 665.

Metalia spatagus Lovén, 1887. Bih. Svensk. Vet.-Akad. Handl., 13 (4), No. 5, p. 162. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XXI b, figs. 8 and 9 (as *Metalia maculosa*).

Petals I and V not at all confluent; primary tubercles present at proximal, dorsal end of interambulacrum 5; vertical diameter usually less than half test length; sternum with a single median point where it meets subanal fasciole.

9 specimens from Gulf of Suez; Red Sea, Suez; Aden; Rotuma (*Gardiner*); Samoa. The specimen from Rotuma was labelled *Brissus unicolor*; all the others were named *M. sternalis*.

An example from Samoa is very large, measuring $102 \times 92 \times 52$ mm.; most are small and those from Suez are so young as to be very perplexing. In one, $26 \times 22 \times 13$ mm., the anal fasciole is hard to see, but was detected when the test was dry; the other, which is $18 \times 13 \times 10$ mm., seems to have no anal fasciole at all. Apparently the anal fasciole is very late in appearing, so that these very young individuals do not seem to be *Metalias* at all.

4. *Metalia sternalis*.

Spatangus sternalis Lamarck, 1816. Anim. s. Vert., 3, p. 31.

Brissus (Metalia) sternalis Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 51. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XXI a, figs. 4 and 5, pl. XXI c, figs. 5-9.

Anterior position of apical system marked; petals I and V more or less confluent proximally, so that there are no primary tubercles at proximal, dorsal end of interambulacrum 5; size often very large.

19 specimens, of which 5 are bare and 2 are without locality labels. Localities represented are: Mauritius; Amirantes; Andaman Islands; Singapore; north-eastern Australia; Pacific Ocean; Kingsmill (= Gilbert) Islands. Of the Mauritius specimens 2 very fine ones were labelled *Brissus unicolor*.

In this series are several of the finest specimens I have ever seen. One from Mauritius is 182 mm. long by 160 mm. wide and 110 mm. high; a bare test without locality is 3 mm. longer and of the same width, but is only 101 mm. high. A very small specimen from the Gilbert Islands is $30 \times 28 \times 20$ mm. The specimen from the Andaman Islands is remarkable for its retention of colour; the test is quite orange-red; many spines are white throughout, but many are orange-red, white at the tip.

5. *Metalia townsendi*.

Eobrissus townsendi Bell, 1904. Ann. Mag. Nat. Hist. (7), **13**, p. 236.

Metalia townsendi H. L. Clark, 1917. Mem. M.C.Z., **46**, p. 213. (No figures have been published.)

Apical system subcentral or slightly anterior; test about half as high as long, its width about 0.80 length.

8 specimens from Persian Gulf, Oman (*Townsend*).

These are the types of this unquestionably valid species. The position of the apical system is not sufficiently important to maintain the genus *Eobrissus*. The apical system is not central; in every specimen it is anterior, and in one 52 mm. long it is 4 mm. in front of the centre. The difference between this species and other *Metalias* is one of degree. The specimens range from $38 \times 31 \times 19$ mm. to $60 \times 49 \times 29$ mm.

4. RHYNBRISSUS.

A. Agassiz, 1872. Bull. M.C.Z., **3**, p. 18.

Type, *Rhynobrissus pyramidalis* A. Agassiz, 1872. Bull. M.C.Z., **3**, p. 18.

Ambulacrum III not at all differentiated abactinally, perfectly flush with adjoining interambulacra; peripetalous fasciole present but no internal fasciole; subanal plastron projecting downward or backward more or less considerably.

1. *Rhynobrissus hemiasteroides*.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 211. 1881, *Challenger* Ech., pl. XXXV b, figs. 12-15.

Test highest at apical system near anterior end, but posterior end about as high; ambitus elliptical; subanal plastron projecting posteriorly, but not to an extraordinary degree.

1 specimen from Tahiti Harbour (*Challenger*).

This is the holotype and measures 35 mm. in length; the width is 30 mm. and the height 20. In 1918 this species was found by Mr. D. Thaanum to be quite common near Lahaina, Maui, in the Hawaiian Islands, in 5-30 fms. Previously it was known only from Tahiti and from Moreton Bay, Queensland.

2. *Rhynobrissus pyramidalis*.

A. Agassiz, 1872. Bull. M.C.Z., 3, p. 58. 1881, Rev. Ech., pt. 3, pl. XXIII a, figs. 4-6.

Test highest posterior to apical system and sloping thence to anterior margin; ambitus rounded pentangular; subanal plastron projecting backward beyond periproct.

1 specimen from India, Tuticorin. There is also, under this name, a small *Spatangoid*, $16 \times 13 \times 10$ mm., from Holothuria Bank, 24 fms., which is too young for determination.

Apparently this is a very rare species; the specimen from Tuticorin considerably extends its range to the westward. This is a small but fine specimen, $38 \times 32 \times 25$ mm., light brown in colour, but with most of the spines white; there is no trace of the purple colour which is so marked in the holotype.

5. BRISSUS.

Leske, 1778. Add. ad Klein, p. xx.

Type, *Spatangus brissus unicolor* Leske, 1778. Add. ad Klein, p. xx.

Peripetalous fasciole present, but no internal and no anal fascioles; petals well formed and depressed; subanal fasciole complete, surrounding a distinct subanal plastron.

1. *Brissus brissus*.

Spatangus brissus (var. *unicolor*) Leske, 1778. Add. ad Klein, pp. xx, 182.

Brissus brissus H. L. Clark, 1917. Mem. M.C.Z., 40, p. 218.

A. Agassiz, 1872. Rev. Ech., pt. 1, pl. XXII, figs. 1 and 2.

Test nearly or quite truncate posteriorly, not overhanging; interambulacrum 5 little or not at all carinate dorsally.

33 specimens, of which 10 are bare and 3 are without locality labels. Localities represented are: Mediterranean; Malta; Naples; Cape Verde; Madeira; St. Helena; Azores; West Indies; Cuba; Jamaica. All were labelled *B. unicolor*.

This is an excellent series of a *Spatangoid* with an unusual distribution; from Malta to Jamaica, from the Azores to St. Helena. One of the specimens from Malta is notable for its large size, $135 \times 100 \times 65$ mm.

2. *Brissus damesi*.

A. Agassiz, 1881. Challenger Ech., p. 197, pl. XXX a, figs. 15 and 16.

Genital pores 3 in genitals 1, 2 and 4, none in 3 and 5; petaloid area small and anterior; ambulacrum III not at all depressed; petals II and IV at right angles to long axis of test; all 4 petals of equal length and with 13 or 14 pore-pairs.

A specimen from *Challenger* St. 122, off the coast of Brazil, 350 fms., mud. A small Spatangoid bearing this name, from *Challenger* St. 75, off Fayal, 450 fms., sand, is less than 10 mm. long, and has no petals and no genital pores.

Agassiz's account of these specimens is not clear, for he begins by a reference to 'small specimens, collected by the *Challenger* at St. 75, off Fayal'. He then refers to a 'smaller' and a 'larger' specimen, showing that he was dealing with two only, and he gives the length of these as 9 mm. and 23 mm. (or 22, in the explanation of pl. XXX a). This figure is made from the larger specimen, and most of his description is based on that one, yet he makes no reference to the existence of 3 genital pores, with none in genital 3. This striking feature is also far from evident in the figure on pl. XXX a, but examination with a lens shows that the artist has drawn definite pores in genitals 1, 2 and 4 and smaller dots, probably not meant for pores, in genitals 3 and 5. In spite of the fact that this larger specimen was not taken at St. 75 it must, I think, be considered the type of *B. damesi*. Its length is 22, not 23, mm.; the width is 16.5 mm.; the height at apex is 11 mm. and just behind the petals in interambulacrum 5 is 12.5 mm. The tips of the posterior petals are 10 mm. from the rear end of the test. The test is nearly bare, but there are a few ophicephalous pedicellariae and one small tridentate; the valves of the tridentate are narrow, somewhat flattened, and in contact for nearly the entire length of the blades. The colour of the specimen is a very light brownish white.

The number and position of the genital pores may well be an individual peculiarity; possibly the number would have been 4 had the specimen grown a little larger. But the form and position of the petals and the shape of the test furnish good specific characters.

3. *Brissus latecarinatus*.

Spatangus brissus var. *latecarinatus* Leske, 1778. Add. ad Klein, p. 185.

Brissus carinatus Gray, 1825. Ann. Phil., 26, p. 431. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XXI a, figs. 1-3.

Brissus latecarinatus H. L. Clark, 1917. Mem. M.C.Z., 46, p. 219.

Test obliquely truncate posteriorly with periproct overhanging subanal plastron; interambulacrum 5 markedly carinate dorsally, at least in adults.

35 specimens, of which 11 are bare and 1 has no locality label. Localities represented are: Red Sea; Mauritius; Amirantes, Eagle Islet; Chagos Archipelago, Salomon Islands (*Gardiner*); Madras; Namyit Island Beach; Philippine Islands; Japan; Misaki; Hawaiian Islands; North Australia, Port Essington; Torres Straits, reef of Attagor; Reef of Oomaga;

East Australia; Great Barrier Reef, Raines Islet; Samoa. There is also a specimen labelled 'Adelaide'. The specimens from Japan are labelled *Brissus agassizii*; those from Attagor, *Metalia pectoralis*, and those from Madras, Hawaii, Oomaga, and Raines Islet, *Brissus unicolor*.

This series shows the great diversity in form, appearance of petals and shape of subanal plastron that the species is well known to exhibit. The 4 specimens from Japan are very dark brown, but I have seen specimens equally dark from other localities; the subanal plastron is low and angular, but specimens from other localities show a similar form, and this is a very variable character; thus *B. agassizii* cannot be maintained.

The specimen labelled 'Adelaide' is very small, 21 by 17 mm., but the identification is probably correct and the locality wrong. One of the specimens from Port Essington is 32 mm. long and 22 mm. wide; the width is thus less than 0.70 of length; this is the narrowest specimen I have seen. One without locality, 118 × 100 × 59 mm., is the widest I have seen, the width being almost 0.85 of the length.

6. MEOMA.

Gray, 1851. Ann. Mag. Nat. Hist. (2), 7, p. 132.

Type, *Meoma grandis* Gray, 1851. Ann. Mag. Nat. Hist. (2), 7, p. 132.

Test large and heavy, with conspicuous petals except in ambulacrum III. a well-marked peripetalous fasciole, no interior or anal fascioles and subanal fasciole imperfect, incomplete dorsally, so there is no well-marked subanal plastron.

1. *Meoma grandis*.

Gray, 1851. Ann. Mag. Nat. Hist. (2), 7, p. 132. 1855, Cat. Rec. Ech. Brit. Mus., pl. V, fig. 2. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XXXIV, figs. 1 and 2.

Colour deep blackish-brown, little affected by method of preservation.

5 specimens, of which 3 are bare, 1 is without locality label, 1 is from Acapulco, 1 from Gulf of California and 2 are labelled 'Australia'.

2. *Meoma ventricosa*.

Spatangus ventricosus Lamarck, 1816. Anim. s. Vert., 3, p. 29.

Meoma ventricosa Lüthen, 1864. Vid. Medd. f. 1863, p. 120.

A. Agassiz, 1872. Rev. Ech., pt. 2, pl. XX, fig. 8, pl. XXII, figs. 3 and 4.

Colour reddish or yellowish-brown, becoming dingy on drying.

4 specimens from the Bahama Islands.

One of these is, I think, much the largest individual of *Meoma* yet recorded. It is 188 mm. long, 158 mm. wide, and 100 mm. high; the height is relatively greater than usual, the width about normal.

7. CIONOBRISSUS.

A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 206.

Type, *Cionobrissus revinctus* A. Agassiz, 1879. Proc. Amer. Acad., 14, p. 206.

Peripetalous fasciole present, but no internal or anal fascioles; posterior end of test projecting as a subanal snout, encircled by the subanal fasciole.

1. *Cionobrissus regularis* sp. nov. PLATE X, figs. 6 and 7.

Test wide, rather low, the posterior end projecting conspicuously below the periproct; length from ambitus in ambulacrum III straight through to periproct 37 mm.; from same to tip of subanal snout somewhat over 40 mm.; width, 33 mm.; height, 22 mm. Peripetalous fasciole well marked. Abactinal system anterior, only 11 mm. from anterior margin; genital pores 4; ambulacrum III not petaloid and scarcely at all sunken; petals I and V 17 mm. long by 3.5 wide, with about 27 pore-pairs on each side; petals II and IV 11 mm. by 3.25, with about 22 pore-pairs on each side. Actinal surface mostly missing, but labrum is 14 mm. from anterior margin and peristome is 7 mm. by 4. Subanal snout conspicuous, surrounded by the conspicuous fasciole; measured from the outer margin of fasciole the subanal plastron is 12 mm. high and 15 mm. wide.

Pedicellariae not abundant, but 3 different forms were found; on the abactinal side anteriorly were a few tridentates, on the remains of the sternum some small globiferous, and on the periproct some larger globiferous ones. The tridentate are not distinctive; the head is about half as thick at base as it is long, and the straight valves, which are some 0.30 mm. in length, are in contact for about one-half their length. The small globiferous pedicellariae are suggestive of *Brissopsis*, particularly of *B. alta* (see Mortensen, 1907. *Ingolf* Ech., pt. 2, pl. XVIII, figs. 27 and 29), but the crown of projecting spicules on the stalk is close to the head and is much more conspicuous, many of the projections being almost as long as the valves (about 0.35 mm.). The larger globiferous pedicellariae are similar, but the valves are 0.40–0.45 mm. long and the blade is twice as long as the basal part.

Colour pale brown, nearly white, the fascioles darker.

Challenger St. 188, west end of Torres Straits (Arafura Sea), 28 fms., mud. One specimen.

This interesting Spatangoid was labelled (and is recorded

in the *Challenger* Report) as *Metalia maculosa*, but the absence of an anal fasciole and the characteristic globiferous pedicellariae show that it is not a *Metalia*, and the projecting subanal snout suggests *Cionobrissus*. Although this is apparently a shallow-water form, and the other known species of *Cionobrissus* is from a depth of 800 fms., there are no important differences and the similarities are striking. Unfortunately the few pedicellariae that have been found in *C. revinctus* are of a simple tridentate form, and give no clue to the relationships of the genus. *C. revinctus* has a somewhat higher test than *C. regularis*, and its dark, rather greenish coloration is very different; in both species the test is fragile, but it is distinctly less so in *C. regularis* than in *C. revinctus*.

2. *Cionobrissus revinctus*.

A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 206. 1881, *Challenger* Ech., pl. XXIII.

Test rather high, the height more than three-fourths of the width; ambulacrum III deeply depressed, so that anterior margin of test is conspicuously notched.

9 specimens from *Challenger* St. 191, near Kei Islands, 800 fms., mud.

Several of these cotypes are in fine condition, but most are more or less broken.

8. PLETHOTAENIA.

H. L. Clark, 1917. Mem. M.C.Z., **46**, p. 222.

Type, *Macropneustes spatangoides* A. Agassiz, 1883. *Blake* Ech., p. 64.

Test large, wide, deeply notched in front at ambulacrum III with a peripetalous fasciole which is double, triple, or even multiple.

1. *Plethotaenia spatangoides*.

Macropneustes spatangoides A. Agassiz, 1883. *Blake* Ech., p. 64, pl. XXVII.

Plethotaenia spatangoides H. L. Clark, 1917. Mem. M.C.Z., **46**, p. 222.

Abactinal system central or somewhat posterior; peristome markedly anterior; primary tubercles present within the peripetalous fasciole in all interambulacra.

1 specimen from *Challenger* St. 33, 435 fms., mud.

This specimen is recorded in the *Challenger* Report as '*Spatangus purpureus*', from 'off Bermuda, 100 fms.', but the label reads St. 33. It is a fine, large example of this rare species, 87 mm. long, 80 mm. wide, and 41 mm. high; the colour is now pale brown. Mortensen (1907, *Ingolf* Ech., pt. 2, p. 128) has already noted that this specimen is a *Macropneustes* and not a *Spatangus*.

9. LINOPNEUSTES.

A. Agassiz, 1881. *Challenger* Ech., p. 167.

Type, *Palaeopneustes murrayi* A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 210.

Paired ambulacra, not petaloid or depressed, or if somewhat petaloid, wide open distally and not abruptly limited by peripetalous fasciole.

1. Linopneustes longispinus.

Eupatagus longispinus A. Agassiz, 1878. Bull. M.C.Z., **5**, p. 191.

Linopneustes longispinus A. Agassiz, 1880. Bull. M.C.Z., **8**, p. 82.
1883, *Blake* Ech., pl. XIX, fig. 1, and pl. XX.

Peripetalous fasciole truly marginal, far from tips of petals ; poriferous areas converging distally.

1 specimen from *Blake* St. 148, off St. Kitts, 208 fms., fine sand, black specks.

This is an excellent example of a very fine species.

2. Linopneustes murrayi.

Palaeopneustes murrayi A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 210. 1881, *Challenger* Ech., pl. XXV.

Linopneustes murrayi A. Agassiz, 1881. *Challenger* Ech., p. 168.

Peripetalous fasciole well above margin near tips of petals ; poriferous areas parallel or diverging ; apical system sub-central or slightly anterior.

18 specimens and a fragment from the *Challenger* coll. : St. 210, Philippine Islands, 375 fms., mud ; St. 232, off Japan, 345 fms., sandy mud. There is also a specimen labelled *Challenger* St. 271 ; but this is an obvious blunder, as that station is in the eastern central Pacific at a depth of 2,425 fms. !

Several of these specimens are more or less bare and some are considerably broken, but more than half are in fine condition.

10. EUPATAGUS.

Agassiz and Desor, 1847. Ann. Sci. Nat. (3), **8**, p. 9.

Type, *Eupatagus valenciennesii* Agassiz and Desor, 1847. Ann. Sci. Nat. (3), **8**, p. 9.

Petals short, well formed, flush, terminated by the peripetalous fasciole ; posterior petals as wide near their rounded tips as at middle ; ambulaeum III not at all depressed.

1. Eupatagus valenciennesii.

Agassiz and Desor, 1847. Ann. Sci. Nat. (3), **8**, p. 9. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XV a, figs. 3 and 4.

Test oval or elliptical in outline, quite flat ; petals I and V much longer than II and IV.

42 specimens, of which 29 are bare and 13 have no locality labels. Localities represented are: Port Jackson; off Port Jackson, 30-35 fms. (*Challenger*); Bass Straits, Flinders Island; Tasmania; Port Dalrymple; Victoria, Port Philip; South Australia.

This is a notable series of a species that is represented in the Museum of Comparative Zoölogy by but 4 old specimens, and in the other collections that I have examined by none. Although Ramsay (1885. Cat. Ech. Austral. Mus., p. 36) gives the range as 'east and north coasts of Australia', he is mistaken, for there are no reliable records north of Port Jackson, and the British Museum series shows that Tasmania and south-eastern Australia are the home of *Eupatagus*. The specimen listed in the *Challenger* Report from St. 188, Arafura Sea, 28 fms., is not a *Eupatagus*, but a *Breynia*.

The finest specimens are from Tasmania, and the largest is $57 \times 47 \times 20$ mm. Those from Port Dalrymple are said to have been found 'under stones' on 'Shear Beacon Reef'. There is considerable diversity in colour, but none are dark and there are no bright tints; the smaller specimens are as a rule white and the larger are brownish-white, pale grey, or pale brown.

11. SPATANGUS.

O. F. Müller, 1776. Zool. Dan. Prodr., p. 236 (printed *Spatagus*).

Type, *Spatangus purpureus* O. F. Müller, 1776. Zool. Dan. Prodr., p. 236.

Peripetalous fasciole wanting; sternum well developed, much longer than wide, fully covered with tubercles; at least 10 distal pore-pairs developed in anterior series of petals II and IV; genital pores 4.

1. *Spatangus capensis*.

Döderlein, 1905. Zool. Anz., 28, p. 624. 1906, *Valdivia* Ech., pl. XXXIII, figs. 1 and 1 a.

Subanal plastron not nearly twice as wide as high; primary tubercles of dorsal side numerous, but not present in ambulacra between end of petal and ambitus; subanal plastron rather small, more or less ventral in position.

6 specimens from Cape of Good Hope; 1 is from *Challenger* St. 141, 98 fms., sand and gravel, and 1 from St. 142, 150 fms., sand; 1 is from off Cape Seal, 80 fms. The others have no definite localities. All were labelled *S. raschii*.

These are good typical specimens and add further evidence in support of the validity of the species.

2. *Spatangus pallidus*.

H. L. Clark, 1908. Bull. M.C.Z., 51, p. 307. 1917, Mem. M.C.Z., 46, pl. CLVII, figs. 1-4.

Primary tubercles of dorsal side few, interambulacra 1

and 4, with 6-12 each; sternum with conspicuous keel; subanal fasciole very wide; colour greyish-lavender.

2 specimens from Japan, 35° 13' N., 139° 44' E., 60 fms., labelled *Lovenia elongata*.

These are typical specimens, but they are small—only 32 and 47 mm. long respectively.

3. *Spatangus purpureus*.

O. F. Müller, 1776. Zool. Dan. Prod., p. 236. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XIX c, figs. 5 and 6.

Primary tubercles numerous; subanal plastron more than twice as wide as high, with a re-entering angle on the upper side.

129 specimens, of which 7 are bare and 16 are without locality labels. Localities represented are: Norway, Hardanger Fjord; North Sea; England, Herne; Shetland, St. Magnus Bay; west of Shetland, 64-75 fms., *Porcupine* Sts. 67 and 68; Scotland, Sound of Sanda, 22 fms.; Kilbrennan Sound, near Trench, 10-14 fms.; off Liverpool; north-west of the Hebrides, *Porcupine* St. 90, 458 fms.; Ireland, Galway, Moyard; 40 miles west of Achill Head, 220 fms. (*Royal Dublin Society*); Island of Jersey; England, Plymouth; Mediterranean Sea; Bay of Marseilles; Malta; Algeria, Bona Bay, 25-65 fms. (*Porcupine*).

This is a very complete series; many of the specimens are young, and a considerable number are very young. 24 specimens from Shetland range from 3 to 22 mm. in length, and 37 from near Trench are of similar size. Some specimens are very large, and one measures 113 × 111 × 44 mm.; this is 2 mm. shorter than the largest specimen recorded by Mortensen, but it is 16 mm. lower and 6 mm. narrower, illustrating well the diversity in form of this species. A large specimen without locality may possibly be a hybrid, for the subanal plastron is only 25 mm. wide, though it is 14 mm. high, and it lacks the re-entering angle on the upper side.

4. *Spatangus raschi*.

Lovén, 1869. Öft. Vet.-Akad. Förh. Stockholm, 26, p. 733. Mortensen, 1907. *Ingolf* Ech., pt. 2, pl. I, figs. 4 and 5, pl. II, fig. 19.

Primary tubercles numerous, present in ambulacra between tips of petals and ambitus; subanal plastron not nearly twice as wide as high and including only 2 pairs of enlarged ambulacral pores on each side.

16 specimens, of which 3 are bare and have no locality label. Localities represented are: Norway; south-western Ireland, 100-180 fms.; west coast of Ireland, 45 miles off Black Rock, 500 fms., and 40 miles off Bolus Head, 115 fms. (*Royal Dublin Soc.*); south-west of Cape Clear, 70 miles, 85 fms. *Research* St. 1, 200 fms., or St. 2, 400 fms.

These are all large adults, up to $120 \times 112 \times 62$ mm. One from off Bolus Head is white, but this may be an artificial condition.

12. GONIMARETIA.

H. L. Clark, 1917. Mem. M.C.Z., 46, p. 240.

Type, *Gonimaretia tylota* H. L. Clark, 1917. Mem. M.C.Z., 46, p. 241.

No peripetalous fasciole; sternum well developed, covered with tubercles; only 4-8 distal pore-pairs developed in anterior series of petals II and IV; genital pores 3; labrum long and narrow.

1. *Gonimaretia tylota*.

H. L. Clark, 1917. Mem. M.C.Z., 46, p. 241. A. Agassiz, 1881. *Challenger* Ech., pl. XXXVII, figs. 1-4 (as *Maretia alta*).

Test wide and flat; 3 large primary tubercles in each of interambulacra 1 and 4, near ambitus.

9 specimens from *Challenger* St. 191, near Kei Islands, 800 fms., mud, and St. 192, near Kei Islands, 129 fms., mud; all labelled *Maretia alta*.

This is the original *Challenger* material, and excepting the single specimen from St. 191, which is poor, is in excellent condition. The specimens range in size from 25×21 mm. to 35×28 , and are not quite so wide, on the average, as the types.

13. MARETIA.

Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 48.

Type, *Spatangus planulatus* Lamarck = *Spatangus ovatus* Leske, 1778. Add. ad Klein, p. 188.

No peripetalous fasciole; sternum small, wide, with tubercles confined to posterior end; labrum very long and narrow; periproct not sunken; genital pores 4.

1. *Maretia ovata*.

Spatangus ovatus Leske, 1778. Add. ad Klein, p. 188.

Maretia ovata Hamann, 1904. Bronn's Thierreich, 2, abt. 3, p. 1397. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XIX b, figs. 7-12 (as *M. planulata*).

Test low and wide; no large primary tubercles in interambulacrum 5 dorsally; primary tubercles in other dorsal interambulacra numerous and not conspicuous.

93 specimens, of which 6 are bare and 5 are without locality labels. Localities represented are: Zanzibar; Mauritius; Maldives, South Nilandi (*Gardiner*); India; Gulf of Martaban; Borneo; Badjoa; Polo Taya, 20 fms.; Philippine Islands, Masbate; Macclesfield Bank, 31-44 fms.; Japan, $39^{\circ} 10' N.$, $139^{\circ} 48' E.$; north-eastern Australia, Clairmont

Island, 11 fms., sand and mud (*Alert*); Flinders Island, 11 fms., sand and mud (*Alert*); Port Jackson (*Challenger*); Admiralty Islands (*Challenger*); Central Pacific Islands; Funafuti; Funafuti Lagoon, 15–25 fms.; Fiji; Levuka Reef (*Challenger*); Kingsmill (=Gilbert) Islands.

The chief interest in this large series lies in the diversity of colour shown. Many, especially of the smaller specimens, are white or pale yellowish, others are more or less marked with darker shades. Those from Japan are whitish and dull light olive. Several from Fiji are prettily marked with dull purple. One from Flinders Island is conspicuous because each ambulacrum except III is dull purple abactinally, on the interporiferous area and near tip of petal, where on each side a branch makes a blotch of purple; just above ambitus in ambulacrum III there is also a purple blotch; the primary spines are banded, colourless areas alternating with dull red-violet. Two examples from the lagoon at Funafuti are very dark, the general appearance being blackish.

Some of the larger specimens, notably several from Flinders Island and the *Challenger* specimen from Levuka, have some primary tubercles in interambulacrum 5, but these are neither large nor numerous enough to cause any doubt about the identification of the specimens. The largest specimen is a very fine one from Mauritius, measuring $69 \times 55 \times 19$ mm.

2. *Maretia parvituberculata*.

H. L. Clark, 1924. S. Afr. Fish. Mar. Biol. Surv., Rep. 4, Sp. Rep. 1, p. 13, pl. IV, figs. 1–5.

Petals widely open distally; primary tubercles numerous in all interambulacra dorsally, but quite small; subanal fasciole often incomplete, or even wanting in fully grown adults.

8 specimens from South Africa, 1 from off Cape Natal, 85 fms., and 7 from off mouth of Umhloti River, 100 fms. All were labelled *Lovenia elongata*.

In his South African Report (1904, Ech. S. Africa, pt. 1, p. 173), Bell lists these interesting Spatangoids as *Lovenia elongata*. The specimen from off Cape Natal is particularly fine, though it is small— $44 \times 34 \times 11$ mm.; the subanal fasciole is narrow but distinct, enclosing an area about 11×6 mm.; the colour is white so far as the test and small spines are concerned, but the large spines are tinged with rose and the longest are rosy-red or banded rose-red and white; the rosy colouring is most marked posteriorly. The specimens from off the Umhloti River are large adults, $60 \times 45 \times 16$ mm. to $75 \times 58 \times 22$ mm.; there is no indication of a subanal fasciole; the colour is reddish-violet, with the small spines whitish, the larger ones tinged with red-violet, and the longest red-violet or banded red-violet and white.

14. PSEUDOMARETIA.

Koehler, 1914. Ech. Indian Mus., Spat., p. 107.

Type, *Maretia alta* A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 360.

Sternum small and wide, with primary tubercles confined to posterior end; genital pores 3; periproct deeply sunken and overhung by posterior end of test.

1. *Pseudomaretia alta*.

Maretia alta A. Agassiz, 1863. Proc. Acad. Nat. Sci. Philadelphia, p. 360.

Pseudomaretia alta Koehler, 1914. Ech. Indian Mus., Spat., p. 107, pl. XI, figs. 9, 14-17, and 20.

Test highest posteriorly; interambulacra 1 and 4 with 3 or 4 large primary tubercles in a group near ambitus.

9 specimens, of which 1 is from Tuticorin, and 8 are from Carcados Carajos, 4 at 30 fms. and 4 at 35 fms.

The specimens from Carcados Carajos are very handsome, deep red purple in colour; they range in size from 23×19 mm. to 40×33 mm.; the height at posterior end is about 0.45 of test length.

15. BREYNIA.

Agassiz and Desor, 1847. Ann. Sci. Nat. (3), 8, p. 12.

Type, *Spatangus crux-andreae* Lamarck, 1816 = *Spatangus australasiae* Leach, 1815. Zool. Misc., 2, p. 68.

Peripetalous and internal fascioles both present; petals short and pointed, more or less triangular; primary tubercles present within peripetalous fasciole.

1. *Breynia australasiae*.

Spatangus australasiae Leach, 1815. Zool. Misc., 2, p. 68.

Breynia australasiae Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 46.

A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XV a, figs. 7-9.

Apical system subcentral or slightly anterior; area within peripetalous fasciole about four-fifths of test length.

36 specimens, of which 2 are bare and 8 have no locality label. Localities represented are: Australia; North Australia, Port Darwin, 12 fms., mud and sand (*Alert*); *Challenger* St. 188, west end of Torres Strait, Arafura Sea, 28 fms., mud; Holothuria Bank, 24-36 fms.; West Australia; Swan River; Queensland, Port Denison, 3-4 fms., sand and rocks (*Alert*); Torres Strait (*Challenger*); Prince of Wales Channel, 5-7 fms., sand and shells (*Alert*); Thursday Island, 4 fms., coral (*Alert*); Lord Howe Island. The specimen from *Challenger* St. 188 was labelled *Eupatagus valenciennesii*.

Many are quite young, the smallest being 15-17 mm. long; these seem to lack the internal fasciole, and as the growth

changes of *Breynia* have not yet been worked out, their identification is not beyond dispute. Among some little ones from Holothuria Bank are 4 labelled *Lovenia elongata*; the smallest is only 7 mm. long, and it, with 2 of the others, is probably not *Breynia*; possibly these may be young *Gymnopatagus*, but no adult of that genus is known from Holothuria Bank or its vicinity. The coloration of some of these young Spatangoids is rather bright, considering the uniformly dull brown colour of the adult; the longest spines show much bright violet or rose-red. The specimen from St. 188, which Agassiz named *Eupatagus*, measures $45 \times 35 \times 17$ mm.; the test is quite flat for a *Breynia*; the colour is light purplish-brown, with the small spines white, the larger ones rosy, and the uppermost quite rose-red. Although I think this specimen is a *Breynia*, it, and the bright-coloured small specimens from Holothuria Bank, may belong to a species distinct from *B. australasiae*.

One of the specimens from Lord Howe Island is notable for its large size—115 mm. long, 86 mm. wide, and 51 mm. high. One of the bare tests without locality label is only 45 mm. high, though it is 112 mm. long.

16. LOVENIA.

Agassiz and Desor, 1847. Ann. Sci. Nat. (3), 8, p. 11.

Type, *Lovenia hystrix* Agassiz and Desor, 1847 = *Spatangus elongatus* Gray, 1845. Eyre, J. Exped. Australia, 1, p. 436.

An internal fasciole present but no peripetalous; large, deeply sunken primary tubercles present in interambulacra on both upper and lower surfaces; sternum with tubercles confined to posterior part; petals I and V well formed.

1. *Lovenia camarota*.

H. L. Clark, 1917. Mem. M.C.Z., 46, p. 253, pl. CLXI, figs. 1-4.

Genital pores 4; periproctal region deeply sunken into posterior end of test, which is broad and flat, highest in interambulacrum 5; only 4 or 5 large pore-pairs on each side of subanal plastron.

11 specimens from the following localities: Holothuria Bank, 34 fms.; *Challenger* St. 188, west end of Torres Straits, 28 fms., mud; Torres Straits, 10 fms., sand (*Alert*). All labelled *Lovenia elongata*.

The *Challenger* specimens are virtually types, as the specimen upon which the species was based is one of the same lot. The *Alert* specimen is a very fine one and has the primary spines present; they are light brown or horn colour, not banded at all. The Holothuria Bank specimens are young, one of the largest being 18×15 mm.; a very small one, labelled

Echinocardium, is of doubtful identity. Adult specimens of *L. camarota* are easily distinguished from *L. elongata*, but it is open to question whether very young specimens of the two species can be separated.

2. *Lovenia cordiformis*.

A. Agassiz, 1872. Bull. M.C.Z., 3, p. 57. H. L. Clark, 1917. Mem. M.C.Z., 46, pl. CLXI, figs. 8-12.

Genital pores 4; periproctal region markedly sunken; test relatively narrow and high, its width about 0.75 of its length or less.

1 specimen from an unknown locality (*Belcher*). Labelled *L. elongata*.

This is $70 \times 50 \times 25$ mm., proportions that indicate *L. cordiformis*. No globiferous pedicellariae could be found to verify this identification.

3. *Lovenia elongata*.

Spatangus elongatus Gray, 1845. Eyre, J. Exped. Australia, 1, p. 436.

Lovenia elongata Gray, 1851. Ann. Mag. Nat. Hist. (2), 7, p. 131.

A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XIX c, figs. 1-4.

Genital pores 4; periproctal region deeply sunken; test wide and low; 6-10 large pore-pairs on each side of subanal plastron.

28 specimens and a large fragment; 2 are without locality labels. The others are from: Aden; Muscat, 10-15 fms.; British East Africa, Wasin, 10 fms. (*Crossland*); Tuticorin; Macclesfield Bank, 35 fms.; Philippine Islands, *Challenger* St. 212, 10-20 fms., sand; Japan; $35^{\circ} 13' N.$, $139^{\circ} 44' E.$, 25 fms.; Misaki; Torres Strait; Thursday Island, 3-4 fms., sand (*Alert*); North Australia, Port Essington; east coast of Queensland, Dunk Island. The specimen from Misaki was labelled *Spatangus lütkeni*, and another Japanese specimen *Lovenia subcarinata*.

There is great variety of size and colour in this series. Some of the young ones are only 30 mm. in length; the largest is the very fine specimen from Misaki, which measures $90 \times 75 \times 30$ mm. The half-dozen young specimens from Macclesfield Bank are very pretty, with red-violet and white markings, and the long spines yellowish with violet bands. The *Challenger* specimen is a big one, but is badly crushed; it is brick-red and yellowish, with the long spines yellow, banded with purple. The specimens from Wasin are also beautiful in their showy violet and yellow. Two young ones from Dunk Island are in shape much like *L. camarota*, but have 7 pore-pairs on each side of the subanal plastron. The large fragment from Thursday Island might perhaps be referred to *L. camarota*.

4. *Lovenia gregalis*.

Alcock, 1893. Journ. Asiatic Soc. Bengal, **62**, p. 175. Koehler, 1914. Ech. Indian Mus., Spat., pl. XII, figs. 6-9 and 11.

Periproctal region little or not at all sunken; test wide and flattened but not heart-shaped, its width 0.80-0.85 of length.

4 specimens: 1 from Bay of Bengal, 475 fms.; 1 from South Africa, Simon's Bay, 10-20 fms. (*Challenger*); 2 from Seychelles, 35 fms. (*Gardiner*). The *Challenger* and *Gardiner* specimens were labelled *L. elongata*.

There is no doubt about the Bay of Bengal specimen, which measures $80 \times 66 \times 27$ mm., but there is room for difference of opinion about the others. They are not *L. elongata*. I think that there is no doubt that the Seychelles and Simon's Bay specimens are one species, and I consider them to be *L. gregalis*, in spite of the shallow water in which they were taken, as I find no character of importance to distinguish them from the Indian species; only 4 tube-feet on each side enter the subanal plastron, and the colour is grey or brownish, with many larger spines white or colourless. The Simon's Bay specimen is $50 \times 42 \times 18$ mm.; those from the Seychelles are younger, 24-26 mm. long, 20-21 mm. wide, and 8-9 mm. high; the anterior furrow is not so deep as is shown in Koehler's figures, but this may be, to some degree, a matter of age.

As the *Challenger* specimen from Simon's Bay is not *L. elongata*, the status of that species as a member of the South African fauna is very dubious. The specimens listed by Bell as *L. elongata* have been shown to be *Maretias*, and the specimen taken by the *Pieter Faure* was a fragment, which could be *L. gregalis* just as well as *L. elongata*.

5. *Lovenia subcarinata*.

Spatangus subcarinatus Gray, 1845. Eyre, J. Exped. Australia, **1**, p. 436.

Lovenia subcarinata Gray, 1851. Ann. Mag. Nat. Hist. (2), **7**, p. 131. A. Agassiz, 1881. *Challenger* Ech., pl. XXXV b, figs. 5-7, pl. XXXVII, figs. 7-9.

Genital pores 4; periproctal region not sunken; width of test less than three-fourths of length.

10 specimens from Luzon, Batavia Roads, and Hong Kong, 10 fms. (*Challenger*).

The 3 Luzon specimens appear to be Gray's types; they are in poor condition. The 3 Batavia specimens are in superb condition; they are light grey-brown in colour. The *Challenger* specimens from Hong Kong are larger—60-62 mm. long and 41-44 mm. wide.

17. ECHINOCARDIUM.

Gray, 1825. Ann. Phil., 26, p. 430.

Type, *Spatangus pusillus* Leske, 1778 – *Echinus cordatus* Pennant, 1777, Brit. Zool., 4, p. 69.

An internal fasciole present, but no peripetalous ; no large, deeply sunken primary tubercles anywhere ; labrum short and wide ; sternum well covered with tubercles.

In addition to the specimens listed below there is a very small Spatangoid from Macclesfield Bank, labelled *Echinocardium*, which I do not think belongs here, and two very small ones from Norway labelled *Spatangus purpureus*, which are not *Spatangus* but may possibly be *Echinocardium*.

1. *Echinocardium capense*.

Mortensen, 1907. *Ingolf* Ech., pt. 2, p. 137, pl. II, figs. 5, 6, and 11.

Anterior ambulacrum little or not at all depressed ; internal fasciole very small, its enclosed area only about one-fourth as long as test ; a distinct saddle-shaped depression in apical region.

18 specimens from Cape of Good Hope, of which 3 are from *Challenger* St. 142, 150 fms., sand, and 1 is from 60 miles west of Cape Town, 100 fms. This last was labelled *E. australe*, and the *Challenger* specimens were named *E. flavescens*.

The largest is $27 \times 25 \times 14$ mm., a trifle larger than the largest of Mortensen's types.

2. *Echinocardium cordatum*.

Echinus cordatus Pennant, 1777. Brit. Zool., 4, p. 69.

Echinocardium cordatus Gray, 1848. Brit. Rad., p. 6. A. Agassiz, 1873. Rev. Ech., pt. 3, pl. XX, figs. 5–7.

Anterior ambulacrum distinctly depressed, beginning at apical system and becoming deep at ambitus ; large primary tubercles in interambulacra 2 and 3 above ambitus.

177 specimens, of which 22 are bare, 8 are without locality, and 110 are from the Far East or the Southern Hemisphere, and are labelled *E. australe*. Localities represented are : Europe ; Lofoten Islands, Svolvær ; England, Lytham ; Isle of Man, Port Erin ; Ireland, Galway, Moyard ; Ballynakill ; England, Eastbourne ; Newhaven ; Scilly Isles ; South Brittany, Concarneau ; Bay of Biscay, Cape Breton ; Mediterranean ; Nice ; Marseilles ; Naples ; Sicily ; Cape of Good Hope ; False Bay, Bakkoen Rock ; 10 miles south of Cape St. Blaize ; Japan, Inland Sea ; Kobe (*Challenger*) ; coast of Korea ; *Challenger* St. 233, Inland Sea, 15 fms., mud ; $35^{\circ} 10' N.$, $139^{\circ} 48' E.$; Australia ; Flinders Island ; Port Jackson (*Alert*) ; Sow and Pigs Bank, 11 fms. ; Van Diemen's Land ; Tasmania ; Victoria, Port Philip ; South Australia ; West Australia ; New Zealand ; Massacre Bay ; Nelson. There

is also a fine specimen from 'Cascais Bay', a place I cannot locate, and 14 young ones said to be from *Challenger* St. 234, but as that station has a depth of 2,675 fms., it is probable that these came from one of the Inland Sea stations. The 2 specimens from Naples and a small one from the Mediterranean were labelled *E. mediterraneum*; 5 without locality were labelled *Rhynchopygus pacificus*, and 4 small ones from the Inland Sea *Metalia* sp. One from the Bay of Biscay was named *E. flavescens*, and the same name was attached to one from the Cape of Good Hope; the 4 from the Lofoten Islands were labelled *E. ovatum*, and one from Nice *Schizaster canaliferus*. Of the specimens from New Zealand, 5 seem to be the types of Gray's *Echinocardium zelandicum*.

This large series of specimens does not reveal any satisfactory way of separating *E. australe* from *E. cordatum*. There is no constant difference between specimens of the same size from England, Japan, South Africa, and Australia. It is true that in the Far East and South *E. cordatum* does not seem to reach nearly so large a size as it does in European seas; the largest extra-European specimen is from Kobe; this measures $44 \times 42 \times 30$ mm. European examples reach twice this size under favourable conditions; one from the Scilly Islands measures $73 \times 63 \times 40$ mm., one from Ballynakill $80 \times 70 \times 40$, and one in a wall case in the Exhibition Gallery, from Moyard, Galway, about 90×80 mm.

3. *Echinocardium flavescens*.

Spatangus flavescens O. F. Müller, 1776. Zool. Dan. Prod., p. 236.

Echinocardium flavescens A. Agassiz, 1872. Rev. Ech., pt. 1, p. 110, pl. XX, figs. 3 and 4.

Anterior ambulacrum little or not at all depressed; prominent primary tubercles above ambitus in all the interambulacra, though they may be few.

20 specimens from Norway, Bergen; and Scotland, Kilbrennan Sound near Trench.

The Kilbrennan Sound specimens are in poor condition, but those from Norway are very fine; they range from very small ones ($5 \times 4 \times 3$ mm.) to adults, $35 \times 33 \times 22$ mm.

4. *Echinocardium mediterraneum*.

Amphidetus mediterraneus Forbes, 1844. Proc. Linn. Soc. London, 1, p. 183.

Echinocardium mediterraneum Gray, 1855. Cat. Rec. Ech. Brit. Mus., p. 44. Koehler, 1899. Rev. Suisse Zool., 6, pl. IV, figs. 1-4.

Anterior ambulacrum depressed, but not within the internal fasciole; no large tubercles above ambitus.

7 specimens: from Spain, Santander; Corsica; Naples; Askalon.

Santander is the extreme northern limit, and Askalon the extreme eastern limit, of the range of this species so far as is yet known. The Santander example gives credence to Fischer's (1869. Act. Soc. Linn. Bordeaux, 27, p. 401) records from Gironde, and suggests that this heart-urchin may be a regular inhabitant of the coasts of the Bay of Biscay. The Santander specimen is a very fine one, $38 \times 36 \times 24$ mm., pure white in colour, probably as a result of bleaching in alcohol. The Corsican and Askalon specimens are bare tests, the latter only $24 \times 22 \times 13$ mm. The 4 specimens from Naples are superb; one of them measures $51 \times 48 \times 35$ mm., the largest and relatively one of the highest specimens on record.

5. *Echinocardium pennatifidum*.

Norman, 1867. Rep. Brit. Ass., 37, p. 440. Mortensen, 1907. *Ingolf Ech.*, pt. 2, pl. II, figs. 13, 15, and 17.

Anterior ambulacrum little or not at all depressed; no large primary tubercles above ambitus in *any* interambulacrum; labrum very short.

12 specimens from the following localities: Scotland, Firth of Lorne, 50-70 fms.; off Liverpool; Scilly Isles; Plymouth; Herm. The specimens from Liverpool and Plymouth were labelled *E. cordatum*, and that from the Firth of Lorne was named *Spatangus purpureus*.

The specimens from Herm are very fine, but those from the Scilly Islands are the largest and best that I have ever seen; the largest one measures $60 \times 55 \times 41$ mm.

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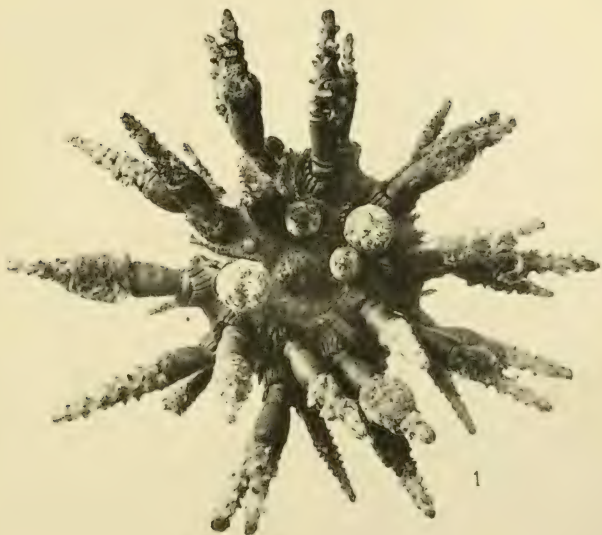
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PLATE I

Chondrocidaris brevispina. (× c. $\frac{3}{4}$).

Fig. 1. Aboral view.

Fig. 2. Side view.



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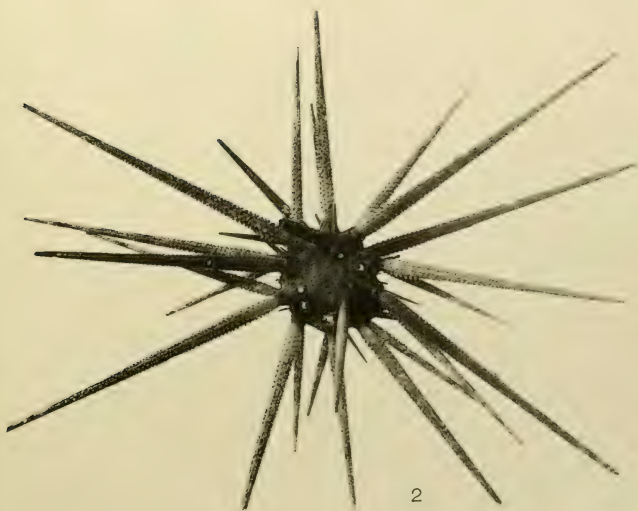
PLATE II

Fig. 1. *Austrocidaris platyacantha*. Side view. ($\times \frac{2}{3}$).

Fig. 2. *Prionocidaris badia*. Aboral view. ($\times c. \frac{3}{5}$).



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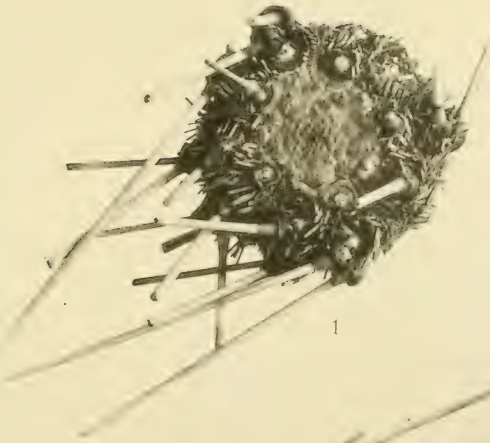
PLATE III

Figs. 1 and 2. *Austrocidaris gigantea*. ($\times \frac{4}{5}$).

1. Aboral view.

2. Side view.

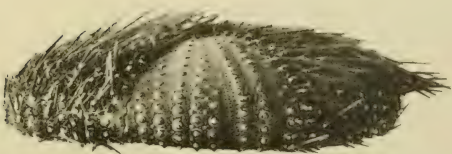
Fig. 3. *Micropygma nigra*. Side view. ($\times \frac{4}{5}$).



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PLATE IV

Micropyga nigra. ($\times \frac{7}{8}$).

Fig. 1. Aboral view.

Fig. 2. Oral view.

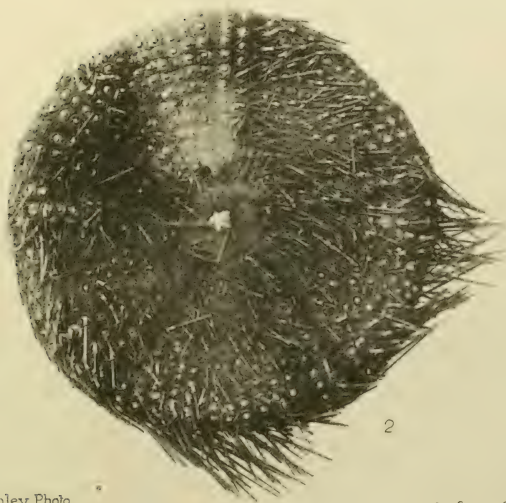
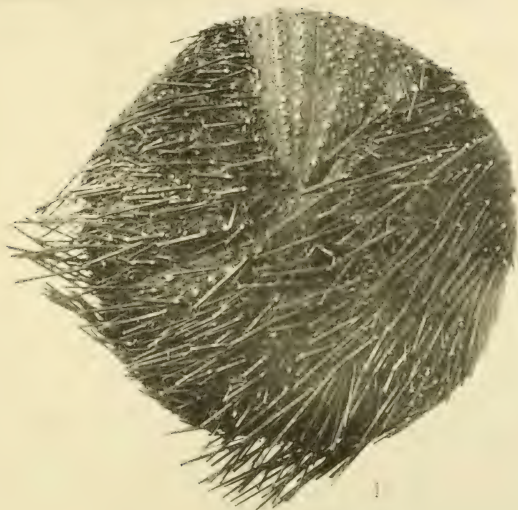


PLATE V

Figs. 1 and 2. *Coenopedina superba*. ($\times \frac{3}{4}$).

1. Side view.

2. Aboral view.

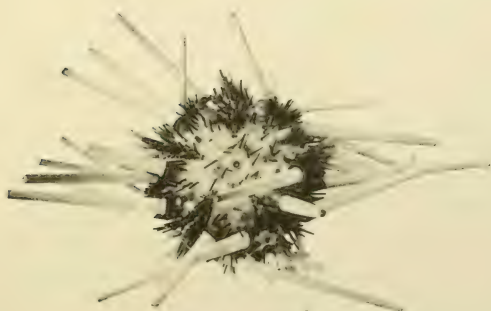
Figs. 3 and 4. *Salmacis rubricincta*. ($\times \frac{3}{4}$).

3. Side view.

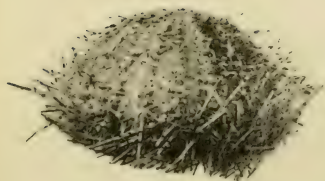
4. Aboral view.



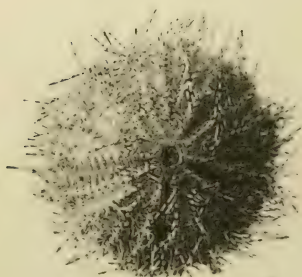
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4

PLATE VI

Echinus multidentatus. ($\times \frac{7}{8}$).

Fig. 1. Aboral view.

Fig. 2. Side view.



PLATE VII

Figs. 1 and 2. *Nudechinus rubripunctatus*. ($\times 2$).

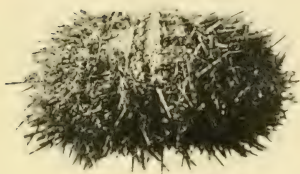
1. Side view.
2. Aboral view.

Figs. 3 and 4. *Gymnechinus abnormalis*. ($\times 4$).

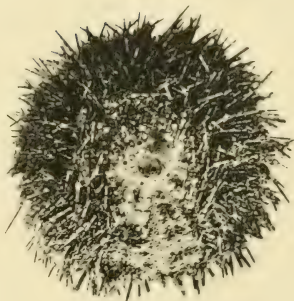
3. Aboral view.
4. Side view.

Figs. 5 and 6. *Temnotrema pallescens*. ($\times 3\frac{1}{2}$).

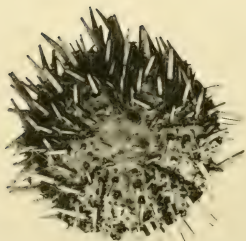
5. Side view.
6. Aboral view.



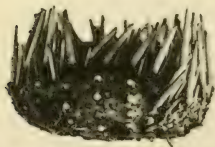
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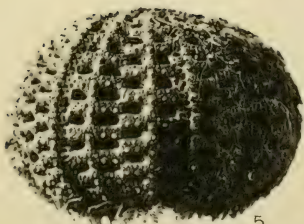
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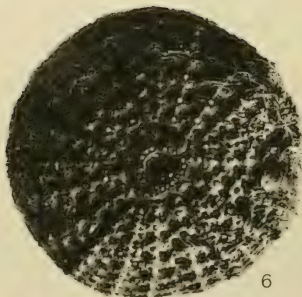
3



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5



6

PLATE VIII

Peronella lesueurii var. *elegans*. ($\times \frac{7}{8}$).

Fig. 1. Aboral view.

Fig. 2. Oral view.



PLATE IX

Figs. 1 and 2. *Laganum centrale*. ($\times \frac{4}{5}$).

1. Aboral view.

2. Oral view.

Figs. 3 and 4. *Echinocyamus crenulatus*. ($\times 4$).

3. Aboral view.

4. Oral view.

Fig. 5. *Clypeaster miniaceus*. Aboral view. ($\times \frac{4}{5}$).

Figs. 6-8. *Echinocyamus grandis*. ($\times 2\frac{1}{2}$).

6. Oral view.

7. Side view (right).

8. Aboral view.

Figs. 9 and 10. *Laganum mirabile*. ($\times \frac{4}{5}$).

9. Aboral view.

10. Oral view.

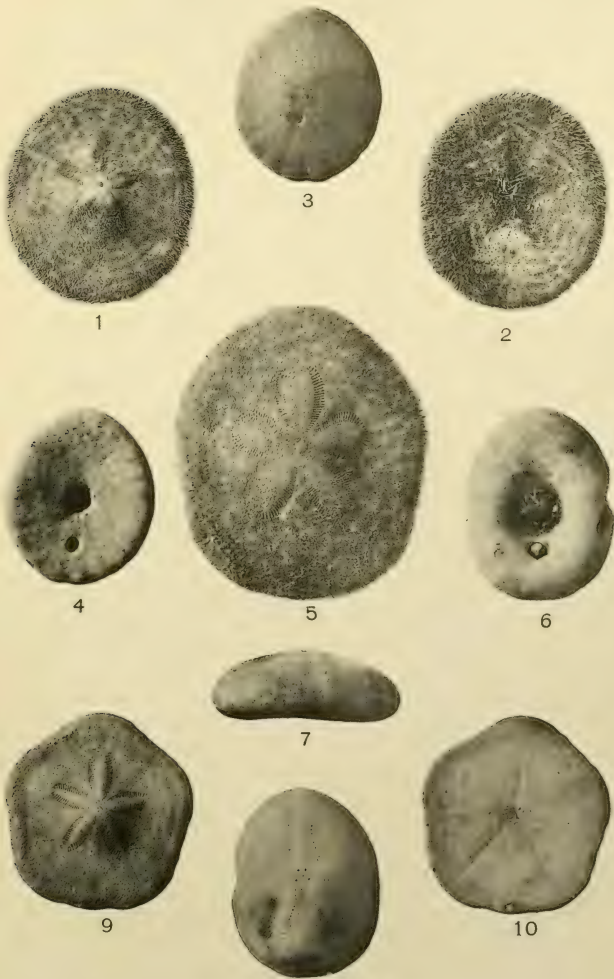


PLATE X

Figs. 1-3. *Echinoneus abruptus*. Nat. size.

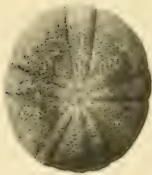
1. Aboral view.
2. Side view (left).
3. Oral view.

Figs. 4 and 5. *Echinolampas koreana*. Nat. size.

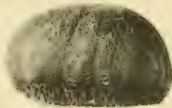
4. Aboral view.
5. Side view (left).

Figs. 6 and 7. *Cionobrissus regularis*. Nat. size.

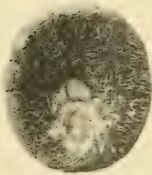
6. Side view (right).
7. Aboral view.



1



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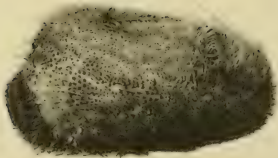
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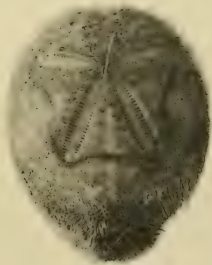
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7

PLATE XI

Figs. 1-3. *Hypselaster fragilis*. ($\times \frac{7}{8}$).

1. Aboral view.
2. Side view (left).
3. Oral view.

Figs. 4-6. *Pericosmus abatoides*. ($\times \frac{7}{8}$).

4. Aboral view.
5. Side view (right).
6. Oral view.

Fig. 7. *Metalia latissima*. Side view, left. ($\times \frac{7}{8}$).

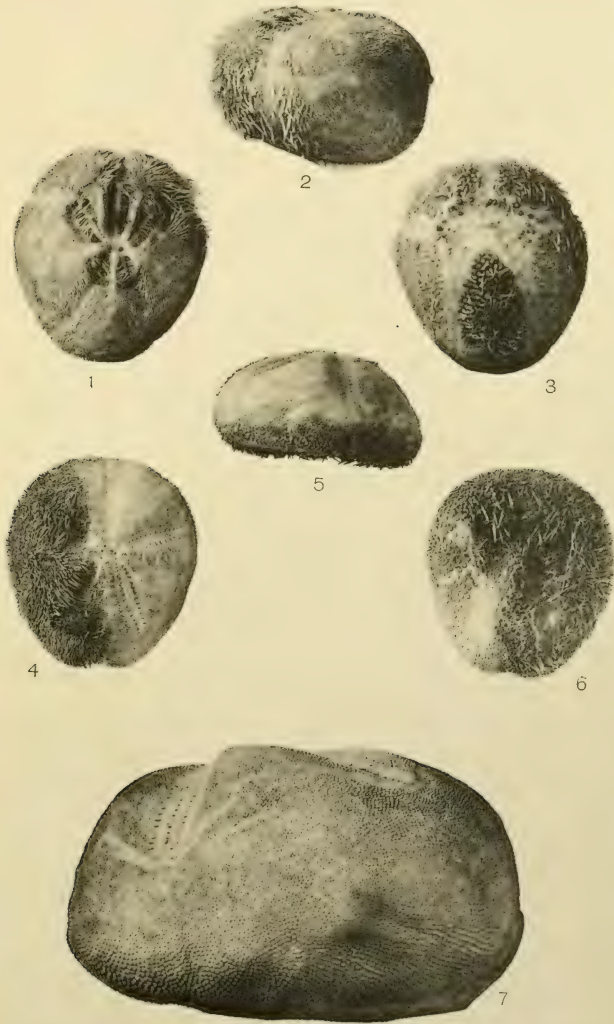
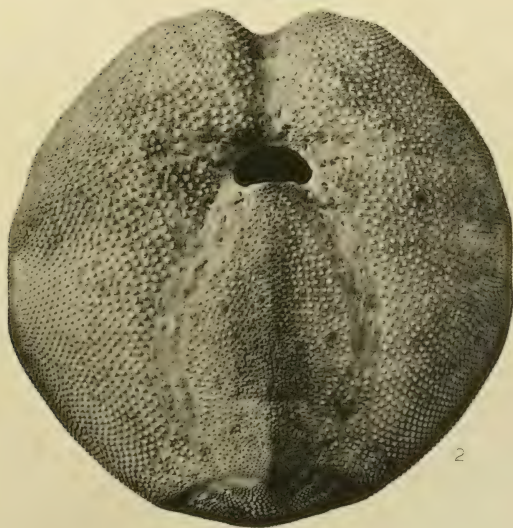
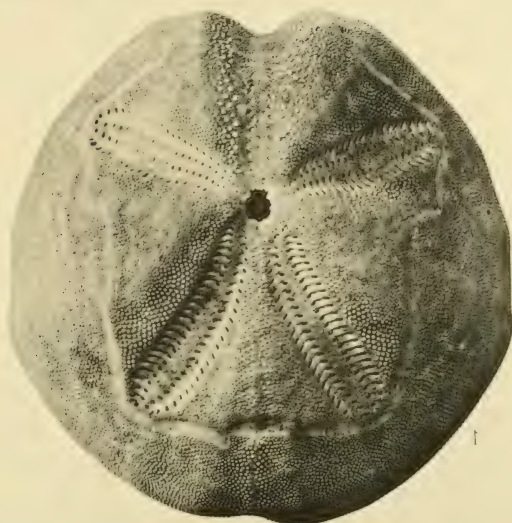


PLATE XII.

Metalia latissima. Nat. size.

Fig. 1. Aboral view.

Fig. 2. Oral view.





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